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RECENT PROGRESS IN THE STUDY OF EARLY MAN[1]

By Sir ARTHUR SMITH WOODWARD

WHEN meeting in East Anglia it is appropriate that the Section of Anthropology should devote some special attention to prehistoric archeology. In this part of England, as long ago as 1797, John Frere made the first scientific observations on Paleolithic implements which he had dug out of a superficial deposit at Hoxne. During recent years J. Reid Moir has excited wide interest by his discoveries of the oldest known stone implements which he has collected with remarkable zeal and discussed with acute observation. Here also arose the "Prehistoric Society of East Anglia," which has been so well supported during its career of over twenty years that it has gradually widened its sphere until now it becomes the "Prehistoric Society" devoted to advances in its subject in all parts of the world. We are, indeed, now confronted with problems much greater than those which the pioneers in western Europe dealt with, when they were laying the foundations of research in prehistory. Traces of men who lived before the dawn of history in widely separated parts of the earth's surface have been discovered in increasing abundance during recent years; and a study which at first was more or less local has now become one of world-wide scope.

Among the several branches of science which contribute to our understanding of the subject, those of paleontology and geology are of considerable importance. Dr. Friedrich E. Zuener has recently demonstrated this by his valuable paper on the Pleistocene chronology of central Europe in the *Geological Magazine* for August, 1935. The period of man's existence on the earth has been so short that there has been no appreciable evolution among the mammals associated with successive human races; but many migrations and extinctions are observable, so that these mammals can often be used for determining the relative ages of the

[1] Address of the president of the Section of Anthropology, British Association for the Advancement of Science, Norwich, September, 1935.

isolated deposits in which human remains and implements occur. In some cases also the mammals are probably enough to show the nature of the climate and the local conditions under which they lived. The contemporary geological changes, though small, likewise help in explaining migrations and perhaps some extinctions; while the peculiar circumstances of the Great Ice Age, under which early man flourished in the northern hemisphere, varied so much from time to time that they have been used in forming a plausible chronology. As a paleontologist and a geologist, therefore, I propose to discuss some of the latest developments of prehistory.

It has long been recognized that the earliest men of which traces have been found in Europe did not originate on this continent but were immigrants from some other region. Western Europe, at least, was a kind of refuge to which successive races retreated. It is thus important to examine the numerous associated mammals to ascertain whence they came; for most of these mammals seem also to have been immigrants to Europe just before or during the Pleistocene period when man began to live here, and they may give a clue to his origins.

Sir W. Boyd Dawkins was one of the first to take a broad view of the mammals which accompanied the successive races of early man in Europe, and he eventually published a map to illustrate their mixed origin. In addition to some which were already in the middle of the European continent, others seemed to have come south from the Arctic regions, others had passed directly west from the middle of Asia, while a few could only be explained as having come north from Africa over old land bridges to Gibraltar and southern Italy. These mammals might not all have lived together, but they at least showed how varied were the routes open to the movements of primitive men.

It now appears that the tracing of the warmer types of mammals to an African source was a mistake. It was due to the erroneous reference of certain fossil elephant teeth from Spain and Sicily to the existing African species, and to the wrong idea that the dwarf elephants found fossil in Malta were closely related to the same species. It was also supported by the fact that the cave hyena of Europe proved to be identical with the spotted hyena, which at present lives only in Africa to the south of the Sahara. Recent researches seem to have proved that during the Pleistocene period there was no direct communication between Europe and Africa, either through Gibraltar or through Sicily or Malta. Geologists are satisfied that certain shells which are characteristic of northern seas could not have entered the Mediterranean to be found there in Pleistocene sea beaches if the Straits of Gibraltar had not been opened. Others have remarked that among the numerous remains of mammals which occur in some of the caves at Gibraltar, there is nothing distinctly African. Dr. Raymond Vaufrey has more recently examined the fossil mammals and stone implements found in the caves and other Pleistocene deposits of Sicily and Malta, and he shows clearly that although these islands were connected with Italy at the time, they never had an extension to Africa.

The supposition that Sicily and Malta are remnants of a former land bridge between Europe and Africa has been so widely accepted that Dr. Vaufrey's conclusions need to be emphasized. There is no doubt that the fossil elephants found both in Sicily and Malta are dwarf forms of *Elephas antiquus*, which was widely distributed in Europe in early Pleistocene times. The fossil hippopotamus of these islands may also have been derived from the species which had already reached southern Europe in the Upper Pliocene. All the fossil mammals, indeed, have European or Asiatic, not African affinities. Associated with them there are no traces of Paleolithic man, such as must have occurred had the islands been a route for migration between Europe and Africa. I agree with Dr. Vaufrey that the two fossil human molar teeth from Malta which have been referred to Neanderthal man are of both doubtful age and uncertain relationship. No Paleolithic implements have been found in Malta, and only very late Paleoliths occur in Sicily above the deposits in which the remains of dwarf elephants and hippopotamus are met with. The earliest stone implements in Malta are Neolithic.

The latest discoveries of fossil mammals in the caves of Palestine and Syria, as interpreted by Miss Dorothea M. A. Bate, show that during the early half of the Pleistocene period, Asia and north Africa were much more closely connected than they have been since. The country was comparatively well watered, with luxuriant vegetation and forests, and mammals could readily migrate both east and west. Even so characteristic an African animal as the wart-hog (*Phacochoerus*) was then living in Palestine. The connection of Asia with Africa was thus as definite as that with Europe; and the explanation of the partial identity between the Pleistocene mammals of Africa and Europe is probably that they had a common source in Asia and diverged west in two different directions, one southwards, the other northwards.

This conclusion is supported especially by the apparent origin and former distribution of the spotted (or cave) hyena, *Hyena crocuta*. In the Pliocene deposits of the Siwalik Hills in northern India, there are jaws and other remains of hyenas which are not quite *H. crocuta* but may well represent its ancestors. By the Pleistocene period the typical *H. crocuta* was already in existence in India, as shown by a tooth dis-

covered in the Karnul caves, Madras. Remains of the same species have also been found in Pleistocene deposits in central Asia and even in China. They are likewise widely spread over Syria and northern Africa, where only the striped hyena (*H. striata*) lives to-day. *H. crocuta,* therefore, is not an African animal. It originated in Asia, spread thence in different directions in the Old World, and has survived only in southern Africa, which is at one extremity of its former wide range.

The origin of the lion is not so clear, but as it still lives in Asia and was widely spread there until recent times, it is at least as much an Asiatic as an African mammal. The same may be said of the leopard and the caffer cat, which are also found sometimes among the European Pleistocene mammals. As the tiger of Asia is still as characteristic of temperate regions as it is of the tropics to which it seems to have migrated only within comparatively recent times, and as the finest examples occur in the Altai Mountains, the original home of the great cats is probably in the north. The fine cave lion of Pleistocene Europe, therefore, seems to have lived under congenial conditions, though they were very different from those under which the African lion exists to-day.

The hippopotamus, which is also at present an African animal, arrived in Europe probably before man, but it survived during the early part of the Pleistocene period when man was here. Even if it did not originate in Asia, it was in India nearly in its present form when the Siwalik rocks were deposited. It may therefore have reached Europe from Asia; and recent discoveries in the caves of Syria show that it was also widely distributed in the direction of Africa. The occurrence of the animal in Europe, even so far north as Yorkshire, has generally been regarded as proving that mild conditions, with open waters, prevailed over Europe when it lived here. A few years ago, however, Marius Maxwell found in the Lorian Swamp of Kenya Colony a peculiar race of hippopotamus which existed in a region of scrub out of reach of water in which it could habitually swim. The Pleistocene hippopotamus of Europe, therefore, may have been adapted to unusual conditions of life.

It is interesting to observe, in conclusion, that none of the characteristically African antelopes occur among the European Pleistocene fauna. Remains of the gazelle have been found, but this animal is as much Asiatic as African. The Saiga antelope and *Nemorhoedus,* which are Asiatic to-day, the one living on steppes, the other on mountains, are the only other antelopes which reached Europe in Pleistocene times; and *Nemorhoedus* seems to have been the ancestor of the little rock-climbing *Myotragus,* which is now extinct, but has been found in caves in the Balearic Isles and perhaps in Sardinia.

The Pleistocene mammals of Europe, therefore, show that when they flourished on this continent, the only direct land communication was through Asia. The earliest races of men must have reached western Europe by that route; and as a succession of stone implements, remarkably similar to that which is now so well known in Europe, has already been found with early Pleistocene faunas in Africa, it might at first be supposed that there were parallel migrations of the same men from the Asiatic to the African continent. Implements, like languages, however, afford no certain clue to the races which made and used them, and the same tools must have been invented independently more than once. As the late Sir Baldwin Spencer remarked, "In Australia we have in use at the present day a practically complete series of stone implements, representing all the various stages of culture known in prehistoric Europe," yet all these implements are the handiwork of a single race of modern man, *Homo sapiens,* at one and the same time. It is therefore unfortunate that hitherto no human remains have been found in undoubted association with any of the earliest implements and Pleistocene mammals in Africa. Two years ago a committee of geologists which met in Cambridge expressed itself as satisfied with evidence which Dr. L. S. B. Leakey submitted in order to prove that he had discovered modern types of human skull and lower jaw with very primitive implements and early Pleistocene mammals in Kenya Colony. In fact, it appeared as if the same types of implements in the same geological stage in Europe and Africa had been made by two distinct genera of men. Quite lately, however, Professor P. G. H. Boswell, under the guidance of Dr. Leakey, has examined the geological formations in the region where the discoveries were said to have been made, and he is now convinced that there is no proof of the association which has been claimed. The human remains in question seem to have been obtained from disturbed deposits and may have been buried at a comparatively recent date. With later types of stone implements and remains of modern mammals, the only satisfactory fragments of the human skeleton which have hitherto been found in Africa belong to the genus *Homo.* Many of the fossil forms are related to the surviving South African bushman, and if any of these passed directly from northern Africa into Spain, as has sometimes been supposed, they must already have learned to make rafts by which they could cross the Straits of Gibraltar.

The only fossil hitherto discovered in Africa, which suggests that that continent may have produced man,

is the immature skull from a deposit of uncertain age (probably Pleistocene) at Taungs in Bechuanaland, which was named *Australopithecus* by Professor Raymond A. Dart in 1925. It belongs to an ape and seems to exhibit more human characters than the skull of any of the existing apes; but Professor Dart's complete account of the fossil has unfortunately not yet been published.

The earliest known jaw of an ape, *Propliopithecus,* was discovered long ago in the Oligocene of Egypt, and numerous jaws of apes related to the existing chimpanzee are now being found in the Miocene of southeast Africa. Equally abundant, however, are the jaws of apes in the Mio-Pliocene deposits of northern India, and some of the teeth preserved in them exhibit a remarkable approach to those of man. I still think, indeed, that according to our present knowledge the links which connected apes with man are most likely to be found in south-central Asia. As the late Joseph Barrell pointed out, the east to west ridge of the Himalayan Mountains was gradually raised up at the time when northern India was covered with a great forest which swarmed with apes of many kinds. The formation of the ridge separated off a northern portion of the forest which became subject to comparatively inclement conditions. The apes stranded in this northern portion would be disturbed by the extensive destruction of the trees, and the survivors would be driven to be ground-apes and change their habits of feeding. They would thus be modified in the direction of man. Regarded from the zoological point of view, of course, man is an arboreal mammal which has left the forest. His remote ancestors, by continuing to live in the forest, preserved their jaws, teeth and limbs nearly on the primitive mammalian plan, while the brain alone made progress; and, as Dr. H. S. Harrison has remarked, if there had been no trees during the Tertiary era, man would probably not have appeared in his present form.

These considerations, with the geographical distribution of the few oldest known remains of fossil man, led the late Dr. Davidson Black to make plans for a systematic examination of the later Tertiary deposits of south-central Asia. In 1925 he reviewed the whole subject in an important paper published by the Geological Society of China. In the summer of 1932 he actually traversed a route from eastern China, through northern India, to Syria and the western coast. Dr. Black, unfortunately, did not live to see the realization of his project, but we are glad to learn that Father P. Teilhard de Chardin will take his place in researches beginning in India this autumn.

It is very interesting to notice that if central Asia was actually the region in which the human family originated, the few known fragments of the oldest fossil men are distributed geographically just as a paleontologist would expect them to be. The late Dr. W. D. Matthew pointed out that if each race of animals evolved at a single center, a succession of waves of increasingly advanced genera must have radiated outwards from that center. The latest and highest types would be found at the actual place of evolution, and they would be surrounded by rings of less advanced types of lower and lower degree until the lowest would occur at the outer limit.

The fragments of the oldest fossil men hitherto discovered are indeed very few, but although allowance for negative evidence may cause some hesitation, it is at least noteworthy that they are all on the periphery of the Euro-Asiatic continental area. *Eoanthropus* and Heidelberg man were found on the western margin of Europe, *Pithecanthropus* at the southern margin of Asia, and *Sinanthropus* close to the eastern coast of Asia. If human types were evolving near central Asia, the places of these actual discoveries are in a distant partial ring round the source.

It is, of course, impossible to be sure that all the primitive men just mentioned were living at approximately the same geological period. They date back to a time evidently before burials, and three of them were found in river deposits, while the fourth was met with under peculiar conditions in a cave. If, however, the geological and paleontological arguments for their correlation be considered, I think it will be agreed that they must have been nearly contemporaneous. The geological age of *Eoanthropus* from Piltdown, Sussex, is perhaps the most difficult to determine, because it was found in a flood-deposit which contains mammalian remains and flint implements of more than one stage at the end of the Pliocene and beginning of the Pleistocene periods. Attempts have been made to sort the fossils according to their color; but the varied staining has no special significance, owing to the irregular distribution of the different ferruginous materials in which they were buried. The color of the first pieces of the skull of *Eoanthropus* itself, indeed, were altered by Dawson, who dipped them in bichromate of potash with the intention of hardening them.

Notwithstanding the difficulty of interpreting the discoveries at Piltdown, I think there is no doubt that the skull of *Eoanthropus* is of the same age as the river gravel itself. It is not water-worn, and the brain-case, the delicate fragments of the face, the half of the lower jaw and the canine tooth were lying separately in four different places, all close together. If these remains had been transported far, and especially if they had been washed out of an earlier deposit, they would not have been associated in this way. Two lower teeth and a piece of the lower jaw of a typically

Pleistocene beaver, found isolated, also seem to be contemporaneous with the gravel; and two teeth of the ordinary Pleistocene *Hippopotamus* appear to be in the same state of mineralization, and are likewise not water-worn. Very similar are the base of an antler of a red deer (*Cervus elaphus*), which is characteristically post-Pliocene, and a piece of the metapodial of a small deer which has evidently been broken and scratched by man. Most significant of all the fossils which are obviously contemporaneous with the gravel and the human skull, is a piece of bone, 16 inches long, which has been worked by man nearly into the shape of the blade of a cricket bat. Direct comparison shows that this piece was flaked from the middle portion of an elephant's femur which was about 5 feet in length. It, therefore, represents an elephant larger than the mammoth of Middle Pleistocene and later date, and doubtless belongs to one of the gigantic Lower Pleistocene elephants, such as *E. meridionalis* or *E. antiquus*.

Highly mineralized and water-worn fragments of teeth of *Mastodon* and *Rhinoceros* (probably *R. etruscus*) are exactly like the fossils from Pliocene crags of eastern England and must have been washed out of a local Pliocene deposit which has been completely destroyed. With them may also be associated some broken fragments of a much mineralized tooth of *Elephas,* which most resembles the Upper Pliocene *E. planifrons.* The fossils clearly contemporaneous with the gravel and with the skull of *Eoanthropus,* therefore, represent a Lower Pleistocene mammalian fauna; while the more highly mineralized fragments have been derived from an earlier formation.

If this mammalian fauna be compared with the fossil faunas occurring in the terraces on the sides of the valley of the Thames, it is found to agree best with that in the "High Terrace," which remains from 80 to 90 feet above the present level of the river. This terrace, which is obviously older than the "Middle Terrace" where the mammoth and woolly rhinoceros are found, is generally admitted to date back to a warm episode at the beginning of the Pleistocene period. The Piltdown gravel with *Eoanthropus,* 80 feet above the present level of the river Ouse in Sussex, may thus be ascribed to the same remote date in the history of man.

The lower jaw of Heidelberg man, *Homo* (or *Protanthropus*) *heidelbergensis,* was found in a river deposit at Mauer, near Heidelberg, in direct association with mammals which are typically Lower Pleistocene in western Europe, though they also include at least two species which are survivals from the Upper Pliocene. In this case the mammalian remains are numerous and well preserved, so that they can be readily named. If, as I suppose, the primitive molar of an elephant at Piltdown is derived from an older formation, not contemporaneous with the gravel in which it was found, there can not be much difference in age between Piltdown and Heidelberg man.

The remains of *Pithecanthropus* were discovered in a river deposit at Trinil in Java, which is a very unstable volcanic region on the southern edge of the Asiatic continent. It, therefore seems possible to date them not only by the associated mammalian remains, but also by the fossil shells in the marine formations, both earlier and later, which now form part of the island of Java. The successive marine deposits, as might be expected, are marked by an increasing percentage of existing species of shells among the fossils. As determined by Dr. L. J. C. van Es, the river deposit at Trinil rests unconformably on a marine formation which is shown by its fossils to be of Middle Pliocene age. The gap in the geological series indicated by this unconformity is filled in other districts by marine deposits which contain 66 to 70 per cent. of existing species of shells, and may, therefore, be regarded as Upper Pliocene. Hence the conclusion that if a marine formation equivalent in age to the Trinil river deposit were found, it would contain more than 70 per cent. of existing species of shells and might thus be referred to the Pleistocene. The percentage of existing species of fresh-water shells in the Trinil deposit supports this conclusion, and as the associated land mammals (*Stegodon, Hippopotamus,* etc.) much resemble those in the Lower Pleistocene Narbada river deposits of India, *Pithecanthropus* evidently dates back to the beginning of the Pleistocene period.

The skulls and lower jaws of *Sinanthropus* were met with not in a river deposit, but in a cave which had evidently been occupied for a long period by man. They were associated with rude stone and bone implements, and even with remains of fires. The deposits in which they occurred are proved by the Chinese geologists to be older than the wide-spread loess of China, which in places contains the remains of the woolly rhinoceros (*R. tichorhinus*), and in other places the mammoth (*Elephas primigenius*). These, it will be remembered, are two of the characteristic fossils of the "Middle Terrace" of the Thames valley, which dates back to the latter half of the Pleistocene period. With *Sinanthropus* are found remains of a large extinct beaver, *Trogontherium,* and a rhinoceros very like *R. mercki,* which are specially characteristic of the "High Terrace" of the Thames already mentioned as the probable equivalent of the Piltdown gravel. If, therefore, the widely distributed mammals just enumerated were living at the extreme eastern and western limits of their range in the Old World at one and the same time, as seems most probable, *Sinanthropus* dates back to the early part of the

Pleistocene period and must have been a contemporary of *Eoanthropus*.

These facts, I think, are enough to show that in the beginning the human skull was much more varied than it is at the present day. There were, indeed, several distinct approaches to modern man before his type became fixed and persistent; just as there were parallel lines of evolution, effective and non-effective, in the ancestry of other modern mammals. That the four known examples of the earliest man were all closely related is proved by the skull of *Sinanthropus*, which exhibits a remarkable combination of the special features of the other three. In the contour of the top of the head, with the great depressed bony brow-ridges, it is so like the skull of *Pithecanthropus* that some anatomists have actually referred it (though without good reason) to the latter genus. In the fine spongy texture of the skull it agrees with *Eoanthropus*, and differs from all other known skulls of men and apes. In its relatively broad base and in the shape of the occiput, it also agrees with *Eoanthropus*. In its lower jaw and teeth, it most resembles *Homo heidelbergensis*.

It is also interesting to notice that at the east and west extremes of their range, these dawn men had attained much the same grade in the habits of daily life. *Sinanthropus* made small stone implements by the rude working of flakes, and they are as varied in shape as the implements met with in the Mousterian deposits of Europe. He cut deer antlers into short lengths and seems to have used the bases of the antlers as hammers. Bits of brain-case seem to have been made into cups; some of the upper jaws were evidently used as files, and some of the lower jaws as small picks, with the coronoid process as working tip. The long bones were often broken to extract the marrow. *Sinanthropus* was also acquainted with the use of fire, and numerous successive hearths were discovered in his dwelling place. *Eoanthropus* similarly made rude stone implements by the chipping of flakes of varied shape, and he also worked bone in such a way as to suggest that he had previously used wood. He also had hammer stones, and he split long bones, doubtless for extracting the marrow. He was similarly acquainted with the use of fire, as shown by the discovery in the Piltdown gravel of charcoal and burnt flints, which include stones indistinguishable from the "pot boilers" of later periods.

Up to the present, unfortunately, the earliest men in other parts of Euro-Asia are known only by stone implements, but these are so widely scattered that there is an extensive area which may be hopefully searched for primitive human remains. The greatest difficulty is one which I have already mentioned, the apparent absence of intentional burials.

The next stage in man's development is much better known, because by this time he had learned to bury his dead in security. As examples have been found in caves so far apart as France and Palestine, burial had doubtless become a general custom. Many whole skeletons are therefore available for study.

This stage is that of Neanderthal or Mousterian man, which is geologically the latest to retain several specially ape-like characters associated in a single individual. Its Asiatic origin is now still clearer to a paleontologist than that of earlier man. Burials in caves which seem to be approximately of the same date reveal a comparatively high Neanderthal type in Palestine, a low and bestial type in western Europe. On Matthew's principle already mentioned, the first is therefore nearest to the original source. The accompanying stone implements support this conclusion, for whereas in western Europe the implements are merely trimmed broad flakes, in Palestine there are also many narrow blades which resemble those made by later (Aurignacian) man in Europe. The Asiatic type of Neanderthal man was indeed progressing in skill to meet his increasing needs.

Since 1913 our conception of Neanderthal man has been based on the admirable description of the skeleton from La-Chapelle-aux-Saints by Professor Marcellin Boule in his classical memoir in the *Annales de Paléontologie*. This and the earlier accounts of more fragmentary remains from the Neanderthal cave in Germany and the Spy cave in Belgium have led to the prevalent idea that the type of man in question exhibited too many degenerate features, added to his ape-characters, to be the ancestor of the modern *Homo sapiens*. A few years ago, however, Dr. Aleš Hrdlička pointed out that other skulls of Neanderthal man, especially those from central Europe and the fragment found by Mr. Turville Petre in Galilee, Palestine, were less different from the skull of modern man than most of the western European examples, and *Homo neanderthalensis* might, after all, prove to be the ancestor of *Homo sapiens* if he could be traced to his source. At last, through the discoveries of Miss Dorothy Garrod and Theodore McCown in the caves of Mt. Carmel, Palestine, we seem to be approaching that source. They have disentombed a series of buried skeletons which are nearly complete; and, according to the preliminary reports on the collection by Mr. McCown and Sir Arthur Keith, they belong to a race which exhibited a remarkable mingling of the characters of Neanderthal and modern man. They seem to show us modern man in the making.

Even the latest phases in the development of stone-age man appear to have begun in Asia, as already generally admitted. It is usually difficult to distinguish the skeletons of domestic animals from those of

wild animals, but Raphael Pumpelly's discoveries in Turkestan show that domestication of several familiar animals was probably beginning there at a very early date in Neolithic times.

Until typical *Homo sapiens* had come into being, man's only outlet from Asia seems to have been by land in the direction of Europe and Africa. As soon, however, as he had attained this final stage of development he must have been able to construct rafts or boats, by which he crossed the narrow seas of the East Indies to Australia, and perhaps the equally narrow seas at Behring Straits to North America.

AUSTRALASIA

Australia is shown by its past and present animal life to have been separated by sea from the rest of the world during the whole of the Tertiary era, including Pleistocene times, and it was isolated too early to be inhabited by the ancestors of the apes. Man is therefore certainly an immigrant from overseas, and we know that he reached the country when various relatively large Pleistocene marsupials were still living there, because a fossil human skull has been found at Talgai in Queensland directly associated with their remains. This skull is essentially the same as that of the existing Australian aborigines, who have retained a mode of life like that of the latest Paleolithic hunters of the mainland. Some of the immigrants evidently took with them a semi-domesticated dog, the dingo, of which fossil remains have been found in old inhabited sites.

It is remarkable that very few traces of men who might be related to the ancestors of the Australians have hitherto been recognized in their homeland in Asia. The skulls of *Homo wadjakensis* from an old lake deposit at Wadjak in Java, discovered and described by Dr. Eugene Dubois, may perhaps be placed among them. The skulls named *Homo* (*Javanthropus*) *soloensis* more recently discovered by Dr. W. F. F. Oppenoorth in an old deposit near the Solo river in Java, seem to be intermediate between the skulls of *Pithecanthropus* and the modern Australian, though they have not yet been described in detail. As many have observed, the skull of Rhodesian man (*Homo rhodesiensis*), from a cave in northern Rhodesia, also exhibits several resemblances to the skull of the modern Australian. Other skulls dug up in South Africa have also been described as exhibiting Australian characteristics. Sooner or later, therefore, fossil ancestral types of Australians will probably be found widely distributed in the tropics of the Old World.

NORTH AMERICA

In at least part of the first half of the Pleistocene period there must have been a direct connection between Asia and North America in the region of Behring Straits. There may have been an isthmus of land, or there may have been only islands and continuous ice; but there was certainly a passage which allowed such mammals as the mammoth, bison, sheep, goat, elk, wapiti, reindeer and black bear to reach America for the first time. So far there is no evidence that man accompanied these animals, and it may be that by then he had not yet reached the northeast corner of Asia. The woolly rhinoceros similarly never passed from Asia to America, although it was abundant and widely spread through the northern lands in the Old World. Its absence from America shows that in some cases there were impediments to emigration.

The earliest traces of Paleolithic man hitherto discovered in North America date back only to the latter part of the Pleistocene period. Last year J. Dorsch, when collecting for Childs Frick, found at Fairbanks, Alaska, some small end-scrapers and conical cores, which Dr. N. C. Nelson recognized as identical with those which he had collected a few years before in large numbers in the Gobi desert. These seem to have been made by some of the latest Paleolithic men; and the only stone implements hitherto found in North America in direct association with the remains of typically Pleistocene mammals show that, when man arrived in that country, he had already learned the supreme art of trimming stone by pressure-flaking. In pattern, indeed, his implements resemble those of Solutrean man in Europe, and even include the familiar Solutrean leaf-shaped blades, besides the characteristic spear points.

The Yuma points, however, as these American spear points have been termed by Professor E. B. Renaud, of Denver, are accompanied by more elaborate points of a peculiar type which has not hitherto been found in the Old World. These are known as Folsom points, from Folsom in Union County, New Mexico, where they occur associated with the remains of an extinct species of bison. The Folsom points are somewhat elongated and pointed blades, with a truncated base which is usually a little excavated; and the middle of each face is hollowed by the skilful removal of a longitudinal flake, which allows it to be clasped by a projection from the end of the spear. These points were, therefore, hafted differently from any of those known from the Solutrean of western Europe. They show that the American late Paleolithic man evolved new ideas on the spot.

The skeletal characters of this race of man are still not known with certainty. The only human bones and teeth hitherto dug up closely resemble the corresponding parts of the surviving North American Indians, and it is uncertain whether any of them are as old as

the remains of the Pleistocene mammals with which they are supposed to have been sometimes associated. The Solutrean-like implements, however, have lately been satisfactorily proved to be contemporaneous with extinct mammals of Pleistocene age in several localities, especially in New Mexico, Texas, Colorado, Nevada and Nebraska.

Two years ago, I had the privilege of visiting one of these localities, by the kind invitation of Dr. John C. Merriam, president of the Carnegie Institution, Washington, and Dr. Edgar B. Howard, of the University of Pennsylvania Museum, Philadelphia. It was on the dry prairie between Clovis and Portales in Curry County, New Mexico. Excavations were then in progress by Dr. Howard and a party of fellow-workers, and the results have lately been described by Dr. Howard himself in a valuable well-illustrated memoir on "Evidence of Early Man in North America," published in the *Museum Journal of the University of Pennsylvania,* vol. xxiv, Nos. 2–3, June, 1935. I can appreciate and endorse his conclusions.

The locality near Clovis is in the course of an old river which deposited gravel and then dried up into a series of shallow lakes which eventually became filled with silt and sand, probably windborne. There are sand-dunes around to-day. In the sandy silt of the old lakes there are well-preserved remains of the mammoth and extinct species of bison, besides fresh-water shells which indicate a colder climate than that of New Mexico at present. There are also stone implements, including Solutrean-like blades and less elaborately worked scrapers; and in one spot the explorers found a mass of charcoal which contained burnt bones and chipped flints, evidently the remains of a contemporary hearth. Beneath the sandy silt several Folsom and Yuma points were obtained, and still further down, below the handiwork of man, there were remains of horses and camels.

In Burnet cave, near Carlsbad in New Mexico, Dr. Howard also found a Folsom point and bone awls directly associated with remains of extinct bison and musk ox, and traces of old hearths; and in Gypsum cave, near Las Vegas in Nevada, Dr. M. R. Harrington, of Los Angeles, discovered stone implements with remains of horses and camels and the small ground-sloth, *Nothrotherium,* again with the charcoal of old hearths. Several other equally clear cases of the association of human implements with typically Pleistocene mammals in the southwestern states of America might be cited, but these are enough to show the nature of the evidence which has been obtained. There can be no doubt that during the latter part of the Pleistocene period, when extensive northern ice still reduced the normal temperature of more southern latitudes, man who made stone implements by the technique which is still practiced by the modern North American Indians was very widely distributed over the continent.

It is generally supposed that a few of the typically Pleistocene mammals survived in North America to a later geological date than any in Europe. The remains of the Ohio mastodon, for example, occur in post-Pleistocene swamp deposits; and dried mummies of the little ground-sloth, *Nothrotherium,* have been found in southern caves with coprolites, which show that it fed on the same vegetation as that which still exists in the neighborhood. It seems, therefore, very difficult to determine the geological age of the earliest man in North America as compared with the successive late phases of stone-age man in the Old World. The only hope centers in satisfactory discoveries of human remains and implements in the deposits on the fluctuating edge of the northern ice-sheet.

South America

Some of the typically Pleistocene mammals in the southern part of South America also appear to have survived until comparatively recent times. Man was almost certainly associated with them, but nothing is known to distinguish this race from modern South American Indians. The supposed ancestors of the human family reported by Florentino Ameghino from the Tertiary rocks of Argentina are due to erroneous interpretation of the fossils, as already pointed out by Hrdlička and others.

The first fossilized remains of man in the South American continent were discovered exactly a hundred years ago in the caves of Minas Geraes, Brazil, by the Danish naturalist, Dr. Peter Wilhelm Lund, whose centenary has just been celebrated by the scientific men of Brazil in Lagoa Santa and Bello Horizonte. Under the direction of Professor Anibal Mattos, three volumes have been published in Bello Horizonte, giving an account of Lund's researches, with a Portuguese translation of his scientific papers. At first Lund hesitated to conclude that the human skeletons which he found in the caves were as old as the bones of extinct mammals with which they were associated: he thought they might be burials or otherwise accidentally introduced into the old deposits. In the end, however, after much experience of many diggings, he became convinced that, although the fossil skeletons were very like those of the existing Botocudos, they must have belonged to a man who was contemporary with the mammals which afterwards became extinct.

Some years ago the late Dr. Francisco P. Moreno, Dr. Rudolph Hauthal and I described the discovery of dried skin and other remains of an extinct ground-sloth (*Neomylodon* or *Gryptotherium*), with fragments of other extinct mammals, in a cave in Last Hope Inlet, Patagonia. Here again, the presence of fires,

cut and worked bone and masses of hay cut for food for the ground-sloth led us to infer that man lived in Patagonia with the various Pleistocene mammals which are now extinct.

REMOTE ISLANDS

The races of men who eventually reached New Zealand and other remote islands were so far advanced in civilized life that they scarcely concern a paleontologist. They only interest him on account of the disturbance of the existing wild life and the extinctions which they have caused. The ethnologist now joins the human anatomist in attempting to explain the distribution of these people and to discover their relationships. They occupy a lowly sphere in the modern world.

SCIENTIFIC EVENTS

INTERNATIONAL HEALTH SERVICES

ACCORDING to the Geneva correspondent of the *British Medical Journal*, the Health Organization of the League of Nations received the usual compliments during the discussions in the Assembly, both in the second committee where the work of the organization is reviewed, and in the fourth, where the budget is approved. The amount estimated in the budget of 1936 for the International Health Organization is 1,180,000 Swiss francs, or about $375,000 at the present rate of exchange. Of this sum the League contribution represents about three fourths, and the remainder is supplied by grants from the Rockefeller Foundation. The allocation which the League itself affords for health purposes is a sum about equal to the contribution it receives from Australia or Czechoslovakia. The health section consists of twenty-three posts, under a medical director, who receives a maximum salary of 53,000 Swiss francs, and eight immediate assistants, whose maximum is 28,000. The grants of the Rockefeller Foundation are made chiefly to provide the salaries of the special technical staff, which comprises a further eleven members, and is engaged in the service of epidemiological intelligence and health statistics.

A contribution of 20,000 Swiss francs annually is made by the Foundation to the Eastern Bureau at Singapore, which is also supported by League contributions and by contributions from certain Governments in the East. This Eastern Bureau has a director, two deputy directors and a staff of ten. Two considerable items in its budget for 1936 are to meet the expenses of a rural hygiene conference and an international course on malaria, both to be held in the Far East. The League is also committed to certain health and other investigations in Latin America, for which a sum of 100,000 francs has been set apart; a part of this will be devoted to the international leprosy center placed under the auspices of the League by the Brazilian Government.

During 1936 the Health Organization will pursue certain special technical studies which have been referred to it, such as rural hygiene and housing, nutrition and physical education. Its permanent tasks are the collection of epidemiological intelligence and health statistics, international studies on malariology, biological standardization, technical studies in the sphere of the campaign against narcotic drugs and general and technical liaison with the national health administrations. The discussion in the Assembly revealed a "push" in various countries towards rural rehousing. Signor Mussolini some time ago ordered a census of rural dwellings throughout Italy, and as a result 170,000 such houses have been marked for demolition, 500,000 for serious reconditioning to make them fit for human habitation and a million more for minor repairs. The Duce has declared that within ten years every agricultural laborer must be provided with a healthy and spacious dwelling. To this end a rural housing exhibition and conference is to be held next year in Rome. France also has made an extensive inquiry into the same subject. To the discussion on health organization Great Britain contributed an account of the forthcoming conference in Geneva on biological standardization, which it is hoped may give rise to concrete proposals for a wider use of the various standards prepared by the permanent commission of experts.

THE FLOWER AND FIFTH AVENUE HOSPITALS OF NEW YORK CITY

AT a meeting of the Board of Trustees of the Fifth Avenue Hospital in New York City, held on October 16, the following members of the Board of Trustees of the New York Homeopathic Medical College and Flower Hospital were elected members of the board of the Fifth Avenue Hospital: William M. Baldwin, Thomas C. Buek, Eversley Childs, Jr., Joshua B. Everett, William H. English, Charles D. Halsey, David Q. Hammond, Clifford Hemphill, James M. Hills, Henry Clay Irons, George Link, Jr., James M. Mathes, Samuel R. Milbank, George S. Piper, Robert T. Pollock, Charles Presbrey and Webster B. Todd.

This action, which follows months of quiet negotiation between the two institutions, represents the first step in developing a close affiliation. For the present, each institution through its respective boards will operate independently although along parallel lines.

At a subsequent meeting held on October 22, the following officers were elected: Claude A. Burrett, M.D., *director;* David Q. Hammond, *superintendent;* Beatrice E. Ritter, R.N., *principal of the School of Nursing.*

The Fifth Avenue Hospital building will be used jointly by both hospitals under one administrative management charged with the responsibility for carrying out the chartered provisions of each.

The Fifth Avenue Hospital, erected in 1922, with a potential bed capacity for 500 patients, has been operated with 285 active beds due to the necessity of utilizing hospital floors for nurses' quarters. Ample opportunity to fully meet the requirements of both institutions for expansion to full capacity waits on the erection of an adequate nurses' home.

Both boards are convinced that the adopted program is mutually advantageous. The Fifth Avenue Hospital will greatly strengthen the educational program of the Flower Hospital. This together with the Metropolitan, one of New York City's great municipal hospitals, will give the college unexcelled opportunity for clinical teaching and research. Flower Hospital, which has been utilizing clinical buildings erected half a century ago, will receive all the advantages of a modern plant and an opportunity to conserve its assets for income. Such conservation will permit the later erection of new college buildings, adequate room for which is available on unused property owned by and adjacent to the Fifth Avenue Hospital should such use prove mutually feasible to both boards of trustees in the future.

It is believed that the medical staffs of both institutions will find increasing opportunity for teaching, research and the care of the sick poor by virtue of this cooperative effort of both boards.

GRANTS IN AID OF RESEARCH OF THE AMERICAN ACADEMY OF ARTS AND SCIENCES

AT its October meeting the Council of the American Academy of Arts and Sciences voted grants-in-aid from its Permanent Science Fund as follows:

To Professor James A. Beattie, Massachusetts Institute of Technology, $500 to assist him in making a study of the relations existing between the International Temperature Scale and the thermodynamic scale.

To Dr. N. T. Bobrovnikoff, acting director of the Perkins Observatory, Delaware, Ohio, $600 for the construction of a grating spectrograph for the Cassegrain focus of the 69-inch Perkins Reflector, to aid in investigation of stellar spectra in the visual and infra-red regions.

To Professor Joseph C. Boyce, Massachusetts Institute of Technology, $400 to be spent for equipment, supplies and assistance in an investigation of the extreme ultra-violet spectra of certain elements.

To Professor Edward Franklin Castetter, University of New Mexico, $100 to aid in the expenses of a field study of the wild plants used for food, ceremonials and medicine by the Mojave Indians.

To Dr. T. T. Chen, Sterling research fellow of Yale University, $300 to aid in completing his collection of Opalinid Ciliates inhabiting frogs and toads as a means of furthering his study of the biology of that group.

To Professor Thomas Harper Goodspeed, University of California, $750 to assist in financing an expedition to South America for the purpose of collecting seeds and specimens of plants of the genus Nicotiana.

To Dr. Helmut Landsberg, Pennsylvania State College, $300 for assistance in compiling and evaluating data in an investigation of suspensions in air with particular reference to the problem of uncharged particles of larger radii.

To Professor K. Lark-Horovitz, Purdue University, $300 for the purchase of certain equipment to be used in a study of low energy particles emitted in nuclear disintegration processes.

The next meeting of the Permanent Science Fund Committee of the American Academy of Arts and Sciences will be held on March 24. Applications for grants-in-aid should be addressed to the chairman of the committee, Professor E. M. East, Bussey Institution, Forest Hills, Massachusetts. Applications to be considered must be received on or before March 1.

PROFESSOR GERRIT GRIJNS

DR. GERRIT GRIJNS, professor of animal physiology in the College of Agriculture of Wageningen, Holland, this year reached the retirement age and gave his final lecture on June 28, after which he was honored by a special committee in the auditorium of the college. It might be of interest to students in nutrition to give here a memorandum of Dr. Grijns's life and work.

He was born in 1865 in Leerdam, the Province of Zuid-Holland, and after attending the secondary school in Delft, he took up the study of medicine in the University of Utrecht, where in 1891 he obtained his degree of doctor of medicine. After this he spent some time in Germany, studying physiology under Dr. Carl Ludwig in Leipzig. At the end of 1892 he departed for the Dutch East Indies as a medical officer and joined the scientific staff of Dr. C. Eijkman, who since 1889 had been the first director of the medical laboratory at Weltevreden, on the island of Java, and who in the course of his experimentations found that beriberi in man was brought about by a long-continued consumption of polished rice. This disease was similar to polyneuritis, a disease he observed when chickens

were fed a diet of polished rice. The disease could be cured by adding "silverskin" to the polished rice.

After an absence of more than a year, during which Dr. Grijns took part in a military expedition, he returned to Weltevreden and succeeded Dr. Eijkman, who in 1898 was nominated professor in the University of Utrecht. Until 1917 and from 1912 on as its director, Dr. Grijns was connected with that laboratory, except for a few years of sick leave, which he spent in Holland. During these years, he confirmed and extended the research work on polyneuritis begun by Eijkman. He was the first to express clearly the conception of beriberi, that it developed when the diet was lacking certain substances which were of importance in the metabolism of the peripheral nervous system. The Indian Government in 1902 was convinced and forbade the use of polished rice in all jails, where from then on beriberi disappeared. Dr. Grijns called it a deficiency disease, since it was due to a deficiency of unknown substances. Curative substances similar to those occurring in rice bran were found in a kind of bean, called Katjang idjo, in meat and in other native legumes. These foodstuffs lost their curative properties when they were heated to 120° C. In another series of experiments he disproved the infection theory and the theory that starch was the cause of the disease and also Schaumann's phosphoric acid and nuclein theory.

During his stay in the Dutch East Indies, Dr. Grijns for several years taught such subjects as anatomy, physiology and legal medicine in the school for the training of native physicians. He also did research on the significance of drinking water, insects and soil being the cause of the spread of infectious diseases, and he investigated the epidemiology of cholera and plague. In 1917, Dr. Grijns returned to Holland, where he became connected with the Colonial Institute for Tropical Hygiene and later again with the laboratory of Dr. Eijkman. From 1921 until 1935 he was professor in animal physiology in the Agricultural College in Wageningen, during which time he continued his studies on vitamins and published several papers dealing with reproduction and fertility in rats. Research workers, throughout the world, who have been concerned with the discovery of the various vitamins, will be interested to know that Dr. Grijns's important papers have been translated into English and published by Noorduin en Toon, Gorinchem, Holland.

With the retirement of Dr. Grijns, the College of Wageningen loses one of its inspiring and much beloved teachers and an able investigator.

M. C. KIK

COLLEGE OF AGRICULTURE
UNIVERSITY OF ARKANSAS

AWARD OF THE JOHN FRITZ GOLD MEDAL

THE John Fritz gold medal has been awarded for 1936 to William Frederick Durand, professor emeritus of mechanical engineering at Stanford University. Professor Durand was cited as an "authority in hydrodynamic and aerodynamic science, and in its practical application; outstanding leader in research and in engineering education."

The award is given each year for "notable scientific or industrial achievement." The Board of Award is composed of sixteen past-presidents of the four national engineering societies of civil, mining and metallurgical, mechanical and electrical engineers. This is the thirty-second award to be made.

Professor Durand is an inventor of precision measuring instruments. Becoming interested in scientific and engineering research early in life, he devoted his attention to mathematics and physics, and to problems of ship propulsion, hydraulics of pipes and aeronautics. He was one of the first men to engage in scientific research in aeronautics. He constructed a wind-tunnel at Stanford University, and conducted a long series of investigations on propellers.

Professor Durand was born in Bethany, Conn., in 1859 and was graduated from the United States Naval Academy in 1880. He served in the Engineers Corps of the Navy until 1887, and then went to the Agricultural and Mechanical College of Michigan as professor of mechanical engineering. He received the degree of doctor of philosophy from Lafayette College in 1888. From 1891 to 1904 he was professor of marine engineering in Cornell University. In the latter year he joined the faculty of Stanford University. The University of California bestowed the honorary degree of doctor of laws upon him in 1923.

In 1914, Professor Durand with others organized the National Advisory Committee for Aeronautics, authorized by the Congress, and was named chairman in 1916. In 1918 he was scientific attaché at the American Embassy in Paris, and served as a member of the Interallied Commission on Inventions.

He was appointed by President Coolidge in 1925 member and secretary of the Aircraft Board, of which the late Dwight W. Morrow was chairman. In 1929 he joined the Advisory Board of Engineers of the Boulder Dam, and has served as consultant on projects of the Bureau of Reclamation, including the Grand Coulee Dam, and the all-American canal near the Mexican border. Last March President Roosevelt named him chairman of a committee to review the entire question of airship design and construction for the U. S. Navy.

Professor Durand is a past president of the American Society of Mechanical Engineers, a life member

and gold medalist of the American Society of Naval Engineers, and a member of many scientific and engineering societies in America, England and France. He was awarded the Daniel Guggenheim medal for aeronautical achievement in May, 1935. He was a trustee of the Guggenheim Fund for the Promotion of Aeronautics throughout the life of that organization. He is the author of technical books and general editor of a study of aerodynamic theory.

RECENT DEATHS

DR. JOSEPH COLT BLOODGOOD, professor of clinical surgery at the Johns Hopkins University and director of the Garvan Cancer Research Laboratory, died on October 23 in his sixty-eighth year.

DR. HENRY SCHWARZ, since 1921 professor emeritus of obstetrics and gynecology at the medical school of Washington University, St. Louis, died on October 23. He was seventy-nine years old.

DR. GEO. GAILEY CHAMBERS, professor of mathematics at the University of Pennsylvania, died on October 4 at the age of sixty-two years.

DR. D. ROBERTS HARPER, 3D, physicist in the coal research laboratory of the Carnegie Institute of Technology, Pittsburgh, died on October 19 at the age of fifty years.

DR. ARCHIBALD PATTERSON KNIGHT, who retired from the professorship of physiology and animal biology at Queen's University, Canada, in 1920, died on October 19, at the age of eighty-six years.

THE death is recorded in *Nature* of Edgar Thurston, formerly superintendent of the Government Museum, Madras, which took place at Penzance on October 5 at the age of eighty years.

THE death is announced, at the age of sixty-six years, of Dr. Gustavus Buchböck, professor of chemistry in the University of Budapest.

A CORRESPONDENT writes: "Gerrit P. Wilder, botanist on the staff of Bernice P. Bishop Museum, Honolulu, Hawaii, since 1924, passed away on September 29 at the age of seventy-eight years. One of the most active horticulturalists in the Pacific, Mr. Wilder made a series of expeditions to Tahiti, the Marquesas, Samoa, Fiji, New Zealand and Australia, the West Indies, Ceylon and other places, introducing into Hawaii many tropical plants and trees. He was a specialist in edible fruits and avocados. Among his publications are 'Fruits of the Hawaiian Islands,' 'The Breadfruit of Tahiti,' 'Flora of Rarotonga' and 'The Flora of Makatea.'"

SCIENTIFIC NOTES AND NEWS

THE Nobel Prize in physiology and medicine was awarded on October 24 to Dr. Hans Spemann, professor of zoology and director of the Zoological Institute at the University of Freiburg in Breisgau, for the discovery of "the organizing effect during embryonic evolution." Prior to the war Dr. Spemann was director of the Kaiser Wilhelm Institute of Biology at Dahlem. He gave the Silliman lectures at Yale University in 1933.

THE Council of the State Medical Society of Wisconsin at the recent annual session in Milwaukee presented its award for distinguished service to the society, the medical profession and public health to Edward Asahel Birge, LL.D., president emeritus of the University of Wisconsin, and to Dr. Arthur Jackson Patek, Milwaukee, founder and for several years editor of the *Wisconsin Medical Journal*. Dr. Birge, now eighty-four years old, was for fifty years associated with the university as instructor in natural history, professor of zoology, dean of the college of arts and sciences (1891 to 1918) and president (1918 to 1925).

DR. EDWARD C. WENTE, research physicist in charge of investigations in acoustics in the Bell Telephone Laboratories, New York, received on October 23 the new Progress Medal, which is to be awarded annually by the Society of Motion Picture Engineers in recognition of leading inventions in motion-picture technology. The medal was awarded to Dr. Wente for his work in acoustics and acoustical instruments with special reference to their application to the recording, transmission and reproduction of speech and music.

FOR distinguished work in the field of ornithology on this continent during the past two years, Herbert L. Stoddard, of Beachton, Ga., was awarded the Brewster Memorial Medal at the Toronto meeting of the American Ornithologists' Union.

DR. LUDWIG PRANDTL, professor of applied mechanics at the University of Göttingen, has been awarded the Ernst Abbe Memorial Prize for Applied Mathematics and Physics, established by the firm of Carl Zeiss, Jena.

THE Harvard Medical School Alumni Association held on October 23 a dinner in honor of Dr. David L. Edsall, who recently retired as dean of the Harvard Medical School. Dr. James B. Conant, president of Harvard University, presided, and speakers included Dr. A. Lawrence Lowell, president emeritus of Harvard University, and Dr. Charles S. Burwell, dean of the Medical School. At a meeting preceding the din-

ner, addresses on "The Development of Medical Education in the United States Since the World War" were made by Dr. Walter A. Jessup, president of the Carnegie Foundation for the Advancement of Teaching; Dr. Eugene F. DuBois, professor of medicine, Cornell University Medical School, and Dr. Lawrence J. Henderson, professor of biological chemistry at Harvard University. Dr. Walter B. Cannon, George Higginson professor of physiology at Harvard University, presided at this meeting.

THE new Erdmann Auditorium was dedicated on October 21 at the New York Post-Graduate Medical School and Hospital. The auditorium was a gift of the board of directors, the faculty association and the members of the professional staff of the hospital and was named in honor of Dr. John F. Erdmann, "in recognition of his signal and devoted services to the institution during the twenty-seven years he has been professor of surgery in the Medical School, for more than twenty of which he has also acted as director of surgery in the hospital." A bronze bust of Dr. Erdmann, presented by the faculty association, was installed at the right side of the auditorium. Dr. Charles J. Imperatori, chairman of the faculty association, presided at the dedication ceremony. The speakers included Drs. Walter Gay Lough, Walter T. Dannreuther, Raymond B. Allen, William B. Talbot, Charles Gordon Heyd and Arthur F. Chace. Dr. Erdmann spoke briefly in acknowledgment.

DEXTER S. KIMBALL, dean of the Engineering College of Cornell University, celebrated his seventieth birthday on October 21.

DURING the recent International Physiological Congress, Professor Carl Voegtlin, of the National Institute of Health of the U. S. Public Health Service, was elected a member of the International Pharmacological Committee. Other members were elected as follows: Professor H. H. Meyer, Vienna; Sir H. H. Dale, London; Professor W. Straub, Munich; Professor Anitschkow, Leningrad, and Professor Tiffeneau, Paris.

OFFICERS of the American Ornithologists' Union have been elected as follows: *President,* A. C. Bent, honorary curator of zoology, Taunton, Mass.; *First Vice-president,* Dr. Herbert Friedmann, U. S. National Museum; *Second Vice-president,* Dr. James P. Chapin, American Museum of Natural History, New York; *Secretary,* Dr. T. S. Palmer, of the Bureau of Chemistry and Soils, Washington, D. C.; *Treasurer,* W. L. McAtee, of the Bureau of Biological Survey, Washington, D. C.

DR. L. WHITTINGTON GORHAM, of Albany, was elected to the presidency of the American Clinical and Climatological Association at the recent fifty-second annual meeting of the association at Princeton. Dr. Alvah H. Gordon, of Montreal, and Dr. Chauncey W. Dowden, of Louisville, Ky., were named vice-presidents. Dr. Francis M. Rackemann, of Boston, and Dr. Francis B. Trudeau, of Saranac Lake, N. Y., were elected secretary treasurer and recorder, respectively. Dr. Walter R. Steiner, of Hartford, Conn., retiring president, together with Dr. O. H. Perry Pepper, of Philadelphia, were elected to the council of the association. Dr. Thomas Darlington and Dr. Alphonse R. Dochez, both of New York, were named delegate and alternate, respectively, to the Congress of American Physicians and Surgeons.

THE Virginia Chapter of Sigma Xi has elected the following officers for the academic session of 1935–36: Professor Walter S. Rodman, dean of engineering, *president;* Dr. Samuel A. Mitchell, director of McCormick Observatory, *vice-president,* and Dr. Joseph K. Roberts, professor of geology, *secretary-treasurer.*

GROVER C. DILLMAN, formerly Michigan state highway commissioner and state welfare director, has taken up his work as president of the Michigan College of Mining and Technology. He succeeds Dr. W. O. Hotchkiss, who resigned to accept the presidency of the Rensselaer Polytechnic Institute.

DR. JOHN H. FOULGER, associate professor of pharmacology at the University of Cincinnati College of Medicine, has resigned to join the staff of the Haskell Laboratory for Toxicological Research, Wilmington, Del. Dr. Norman A. David, assistant professor of pharmacology at the West Virginia University School of Medicine, has been appointed assistant professor at Cincinnati.

SUBRAHMANYAN CHANDRASEKHAR, fellow of Trinity College, Cambridge, has been appointed lecturer in cosmic physics at Harvard University.

AT Kansas State College, Dr. Julius T. Willard, formerly professor of chemistry, vice-president since 1918 and a member of the faculty for fifty-two years, will be relieved of his present work and will become college historian on January 1. It is expected that Dr. Willard will complete a history of the college in time for publication in 1938 when the seventy-fifth anniversary of the founding of the institution will be observed.

STAFF members of the Perkins Observatory, Delaware, Ohio, have been given faculty rank in the department of physics and astronomy of the Ohio State University. These appointments have been made in accordance with the agreement by which the observatory is now operated jointly by the Ohio Wesleyan and the Ohio State Universities. Dr. Nicholas T. Bobrovnikoff,

acting director, has been made an associate professor. J. Allen Hynek, first assistant, and Philip C. Keenan, second assistant, have been made instructors.

PROMOTIONS at the Michigan College of Mining and Technology include: from associate professor to professor of geography and modern languages, Dr. Ella Lucille Wood; from assistant to associate professors, J. M. Harrington and Fay Partlo, of the mathematics and physics staff, Dr. L. A. Rose in English and Dr. E. W. Schilling in electrical engineering; from instructors to assistant professors, J. L. Byers and Frank Tolonen, of the department of metallurgy, Russell Johnson in mechanical engineering, H. E. Krumlauf in mining engineering and D. P. Sherman in economics; from research assistant to research engineer, Walter Keck; from assistant to instructor in geology, Kiril Spiroff. Mr. Spiroff was also named assistant curator of the mineralogical museum. U. J. Noblet adds the title of assistant professor of physical education to that of director of athletics.

THE following new appointments have been made to the faculty of the Duke University School of Medicine. Instructors: biochemistry, Drs. T. B. Coolidge and H. D. Tidwell; medicine, Dr. W. M. Nicholson; bacteriology, Dr. N. F. Conant and Dr. Louis Spekter.

THE resignation of Professor Harlow Shapley, head of the Harvard College Observatory, from the Harvard council of the faculty of arts and sciences has been announced. Professor Shapley gave as his reason for resigning the increased pressure of duties in preparation for Harvard's tercentenary celebration in 1936. He will be replaced by Dr. Julian Coolidge, professor of mathematics and master of Lowell House.

MICHAEL I. TOMILIN, research assistant in the laboratory of comparative pathology at Yale University under Dr. Yerkes, has been appointed anthropologist at the Philadelphia Zoological Garden.

MISS ETHEL ZOE BAILEY has been appointed curator of the Bailey Hortorium at Cornell University. Miss Bailey has been associated for many years with her father, Dr. Liberty Hyde Bailey, in the collection, preparation and care of the materials in the Bailey collection.

DR. WILLIAM BEEBE, with staff of five, has returned from the twenty-first expedition of the department of tropical research of the New York Zoological Society. Five months were spent in field work in Bermuda. Attention was chiefly directed to development and other ecological studies of deep-sea eels, *Histrio* and shore fishes, to the food of tunas and to experiments with powerful, submarine, ultra-violet beams.

PROFESSOR MORTIER F. BARRUS, of the department of plant pathology at Cornell University, is spending a year's leave reorganizing the agricultural extension service of the University of Puerto Rico.

DR. WILLIAM M. WHEELER, professor of entomology, emeritus, and associate curator of insects at the Harvard Museum of Comparative Zoology, attended the meeting of the British Association for the Advancement of Science, at Norwich, from September 4 to 11, and, with Dr. Neal A. Weber, presented a paper on "Unusual Prevalence of Sex-Mosaics (Gynandromorphs) in a Colony of Trinidad Ants."

DR. HAROLD C. UREY, professor of chemistry at Columbia University, gave a lecture on "Heavy Water" on October 16, before the Franklin Institute, Philadelphia.

THE fall lecture before the Sigma Xi Club of Massachusetts State College, Amherst, on the evening of October 31 by Dr. C. Stuart Gager, of the Brooklyn Botanic Garden, was entitled "The Greatest Scientific Discovery." In the morning, Dr. Gager addressed the convocation of the college, speaking, by request, on "The Work of the Brooklyn Botanic Garden," using that as a concrete illustration of ways in which botanical science may serve the public.

THE date of meeting of the conference at Luzerne of the International Union of Chemistry has been changed. It will open on the evening of Sunday, August 16, 1936, and will last until August 22.

DR. H. B. GOODRICH, Wesleyan University, Middletown, Conn., secretary of the American Society of Zoologists, writes that the society will meet in association with a regional meeting of the Genetics Society of America at Princeton University on Monday, Tuesday and Wednesday, December 30, 31 and January 1. In addition to the usual program of papers and demonstrations there will be a joint symposium of the two societies on the "Species Problem" on Monday afternoon. The speakers are to be Dr. Edward M. East, Dr. W. H. Longley, Dr. Alfred C. Redfield and Dr. Curt Stern. A biologists' smoker will be held Monday evening in Proctor Hall of the Graduate College. The annual dinner open to members of both societies will be held on Tuesday evening at which the address will be given by the president of the society, Dr. Robert Hegner, on the topic "Multum ex Parvo." Visits to the Rockefeller Laboratories in Princeton and to the Wistar Institute Farm will probably be arranged. The last date for submitting papers to the secretary to be placed on the program is November 10. Any member who has not received the annual announcement of the meetings should make certain that his correct address is on file with the secretary.

THE Department of Physics of the University of Pittsburgh is sponsoring on November 15, at the Uni-

versity Club, a Conference on Industrial Physics. The purpose of this conference is to direct attention to the increasingly important part which physics and physicists are playing in industry and to provide facilities for the interchange of ideas on industrial physics. The tentative program follows: "Putting Physics to Work," Dr. A. W. Hull, General Electric Research Laboratory; "New Electronic Tubes and their Uses," Dr. D. L. Ulrey, Westinghouse Electric and Manufacturing Company; "What X-rays Can Do for Industry," Dr. V. Hicks, University of Pittsburgh; "Copper-Oxide Rectifiers and Their Applications," Dr. L. O. Grondahl, Union Switch and Signal Company; "How Physics Is Applied in the Oil Industry," Dr. P. D. Foote, Gulf Research Laboratory; "Spectroscopy in Industry," Dr. Keivin Burns, Allegheny Observatory; "Applications of Thermodynamics to Alloy Systems," Dr. William L. Fink, Aluminum Company of America; "Physics and Air Conditioning," Dr. Emerson Pugh, Carnegie Institute of Technology.

THE Central Pennsylvania Branch of the Society of American Bacteriologists held its annual fall meeting at the Pennsylvania State College on October 18. A dinner was held at the University Club at which Dr. R. R. Mellon, of the Western Pennsylvania Hospital of Pittsburgh, addressed the members and their guests on "Life Cycles of the Mycobacterium Tuberculosis." Dr. John W. Rice, of Bucknell University, succeeds Dr. J. A. Sperry, head of the division of bacteriology of the Pennsylvania State College, as president of the branch.

THE A. Cressy Morrison Prize in Natural Science of the New York Academy of Sciences, for the most acceptable paper in a field of science covered by the academy or by an affiliated society, will be awarded on December 16. The papers submitted must embody the results of original research not previously published.

THE U. S. S. R. has been admitted to membership in the International Commission on Illumination, according to an announcement by G. H. Stickney, president of the United States National Committee. With the addition of Spain, which was admitted to membership during the convention in Germany last July, there are now seventeen countries affiliated with the commission.

APPLICATIONS for various grades of public health consultants, and for public health research assistant, must be on file with the U. S. Civil Service Commission, Washington, D. C., not later than November 25. Optional subjects for the consultant positions are: Maternal and child health, general public health practice and orthopedics. The specialty for the research assistant is maternal and child health. Entrance salaries for the consultant positions range from $2,600 to $4,600 a year. The entrance salary for research assistant is $2,000 a year. These salaries are subject to a deduction of 3½ per cent. toward a retirement annuity. Vacancies in these positions in the Children's Bureau, Department of Labor, and in the U. S. Public Health Service, Treasury Department, both in Washington, D. C., and in the field, will be filled from these examinations. Certain education and experience are required.

MOUNT SINAI HOSPITAL, New York City, as the residuary legatee, receives more than $1,300,000 from the estate of Miss Bertha Weinman. A bequest of $25,000 is made to the College of the City of New York for its library, in memory of Moses Weinman.

PUBLIC bequests amounting to $902,553 are made in the will of Mrs. Margaret I. Howe, who died in Brooklyn on January 8. The largest single bequest is the sum of $200,000 to the Brooklyn Museum of Arts and Sciences. Seven other institutions received shares of the residuary estate and remainder interests in trust funds after the deaths of the life beneficiaries.

THE Society of the New York Hospital, as residuary legatee, is the principal beneficiary of the estate of the late Mrs. Jane O. Sheldon, which includes also the residuary estate of Mrs. Sheldon's sister, Susan E. Urie. Fourteen charitable and civic institutions receive bequests amounting to $177,000. The residuary estate is of undetermined value.

DR. AVERY A. ASHDOWN writes: "In examining the obituary notice of Arthur Dehon Little, SCIENCE 82, 362 (1935), I noticed, with regret, that an error had slipped my attention in the galley proof. The fifth paragraph, line two, should read William H. Walker where Willis R. Whitney stands."

DISCUSSION

"REMARKS ON SULAIMAN'S THEORY OF RELATIVITY"

UNDER the above heading, D. R. Hamilton, of Princeton University, has criticized my theory.[1] My humble claim is that, without making the unconvincing assumptions and involving oneself in the serious anomalies of the generalized theory of relativity, all its results can be obtained from the Newtonian mechanics if Newton's method of working, based on the as-

[1] SCIENCE, 81: 2098, 271–272, March 15, 1935.

sumption of the infiniteness of the velocity of propagation of gravitational action, *i.e.*, forces act in the same way whether a body is stationary or is moving, is corrected.

I must at the outset remove the misapprehension that my mathematical theory is based on the assumption of the existence of gravitons. For the purposes of mathematical analysis, it was considered convenient to concentrate attention on the path of a particle. But it was pointed[2] out on page 5, paragraph 2 (and again on pages 219, 229, 236 and 261 in the later chapters), that gravitons are not at all necessary for the theory. *There is only one solitary assumption, and no more, viz., that all influences travel with finite and not infinite velocities.* The rest are mere mathematical deductions from this one single assumption. LeSage's theory has been misunderstood to be identical with mine, as it was not one of emission but impact of corpuscles and led to proportionality to dimensions and not masses.[3] When the assumption of gravitons is dispensed with, the analogy of LeSage's physical theory altogether disappears.

It is gratifying that there are no adverse remarks regarding my formulae for the deflection of light and the vibration of solar atoms, and it is acknowledged that my result regarding the advance of the perihelion is close to the desired value. These are three chief results on which the claims of general relativity are based. The criticism of Mr. Hamilton is directed exclusively against the resultant perturbations in the semi-major axis and the eccentricity. The remark that calculations of these perturbations had not been carried out by me is surprising, as their exact values were actually worked out at some length on pages 20–22. The further consideration of these perturbations was intentionally postponed to a later chapter because I was first concerned with offering substitutes for the three main results of general relativity, which, it was previously believed, could not be deduced from Newtonian mechanics.

The great Laplace was, of course, aware of the aberration phenomenon, and Tisserand also made use of it. But as has been conceded, their methods were quite different, and did not yield any formula tallying with the observed advance of the perihelion. The gravitational deflection of light and the red shift of the spectral lines were not considered by them and indeed were not known at the time. The law of force adopted by them was the plain Newtonian law, which made the integration easy. Laplace's theory was based on the idea that the attraction was produced by the impulse of a fluid on the center of the attracted body, and accordingly it led to a retardation of motion. My equations are based on the well-known principle of retarded potential for electric attraction, and lead to acceleration. They also contain additional terms which render the equations extremely complex and incapable of exact solution. Only a few solutions by successive approximations, by omitting higher powers, have been published by me. As objection has been taken to my work on the basis of these perturbations, I must now briefly announce how I intend to meet them in a later chapter.

In the first place, it is submitted that calculations based on yearly increases for a large number of revolutions are fallacious. The curve found by the approximate solutions, which do not involve it, merely represents a geometrical picture of the orbit and that too *only within the limits of the approximations.* It does not at all profess to give the whole history of the revolutions of a planet for a long period. The fallacy underlying the contrary assumption becomes at once apparent when similar increases are applied to Professor Einstein's equation for the curve and his value for the advance of perihelion[4]:

$$u = \frac{\mu}{h^2}\left[1 + e\cos(\phi - \omega) + \frac{3\mu^2}{c^2h^2}\cdot e\cdot(2n\pi + \phi)\cdot\sin(\phi - \omega)\right]$$

$$= \frac{\mu}{h^2}\left[1 + e\cos(\phi - \omega - \delta\omega)\right]$$

where

$$\cos\delta\omega = 1, \text{ and } \sin\delta\omega = \delta\omega = \frac{3\mu^2}{c^2h^2}\cdot(2n\pi + \phi).$$

These break down when n is large. The obvious explanation is that the geometrical shape of the orbit is one thing and its whole history through its spiral path is quite another.

In the second place, it will be seen that the force of gravitation along the shifted direction has a very large component along the radius vector, which accounts for the orbit being a Keplerian ellipse, while the component along the transversal is very small, of the order of 1/10,000 in the case of the earth. This latter component can be resolved into two still smaller components along the normal and the tangent, respectively. Quoting Laplace, Mr. Hamilton remarks: "The resulting tangential acceleration (retardation?) of the planets had no effect on the longitude of perihelion but introduced secular perturbations in the semi-major axis and eccentricity of the orbit and in the mean longitude of the planet in the orbit." On the authority of Jenneck and Chazy, he concludes that

[2] *Proc. Acad. Sci.*, U. P., India, Vol. 4: Parts I and IV.
[3] Lorentz, "Lect. on Theo. Phys.," Vol. I: 151–152.
[4] Sir A. S. Eddington, "Relativity," p. 88.

the velocity of gravitation would have to be extremely large. He argues that otherwise Mercury would leave the solar system in about 300 years from now, and that, if the velocity is so large, the advance of perihelion would be negligible. Now Laplace and Tisserand could not assume a resisting medium because their equations led to a retardation, and a resisting medium would have made things worse. But in my theory the resisting medium, through which the planets move, acts tangentially in the opposite direction, counteracts the tangential acceleration and, while producing a null effect on the advance of the perihelion, reduces the dreaded perturbations!

Admittedly, the sign predicted by my formula, in the case of the eccentricity of Venus, the earth and Mars, agrees with Newcomb's observations.[5] In the case of Mercury, which passes closer to the sun, the retardation just overcomes the acceleration, and the discrepancy changes sign. In the case of Encke's comet, which passes closer still, the resistance is so great that it actually causes a marked shortening of the period!

It is, therefore, rather premature to jump to the conclusion that my theory will, of a necessity, founder ultimately on this yet untouched rock. The only phenomenon which can be exactly observed because of accurate photography is the deflection of light from a star passing close to the sun. My result, which accords fairly closely with the present known values, differs widely from that obtained from the generalized principle of relativity. The next solar eclipse on June 8, 1937, in Peru will furnish the final test. In the meantime, Chapters III, IV and V, dealing with the "Expanding Universe" and "Special Relativity," have also been published, though owing to the length of the paper the last sections relating to experiments are unfortunately not full. Criticisms thereon would be welcome.

S. M. SULAIMAN

ALLAHABAD, INDIA

IN the above defense of his "theory of a new relativity," Sir Shah Sulaiman does not deny the main point of the author's original criticism, namely, that the new theory in its published form predicts a yearly secular logarithmic perturbation of Mercury's eccentricity of the order of $+1.3\times10^{-2}$, whereas that observed is -4×10^{-8}; and while the point is made that the signs of predicted and observed perturbations agree for Venus, the earth and Mars, it should be remembered that the predicted values range from 6×10^{4} to 2×10^{6} times the observed changes of the eccentricity.

The statement is made that "the resisting medium, through which the planets move, acts tangentially in the opposite direction, counteracts the tangential acceleration and, while producing a null effect on the advance of the perihelion, reduces the dreaded perturbations"! Also, "only a few solutions by successive approximations, by omitting higher powers, have been published by me." The inference is that an attempt is to be made to modify the present results by the consideration of higher order terms and the introduction of a resisting medium (which has not been considered in the two papers thus far published). However, as regards higher order terms, the author has found since the publication of his original comments on Sulaiman's theory that a consideration of *all* terms of order $1/D^2$, which were introduced by Sulaiman himself (D being the velocity of propagation of gravitation, assumed equal to the velocity of light), several of which were subsequently neglected by Sulaiman, converts the previously obtained correct advance of the perihelion to an actual retrogression, in absolute magnitude one sixth the previously predicted advance; but the perturbations of the eccentricity and semi-major axis remain unaltered. An *ad hoc* resisting medium may cancel out the latter undesired perturbations, but as Sulaiman points out above, it can have no secular effect on the longitude of perihelion.[1] Prediction of the proper perihelion advance was supposedly one of the strongest points in support of the new theory.

The details of these corrections to Sulaiman's theory, as well as a complete account of the numerical perturbations predicted by Sulaiman's formulae, are to be published shortly.

D. R. HAMILTON

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THE NEW ERGOT ALKALOID

H. W. DUDLEY and C. Moir,[1] M. S. Kharasch and R. R. Legault,[2] M. R. Thompson[3] and W. A. Jacobs and L. C. Craig[4] have published in this journal their investigations on new physiologically interesting substances isolated from ergot of rye. Since Sir Henry Dale[5] has continued the discussion by means of a brief on the question of priority and especially on the naming of the new ergot alkaloid, I take this opportunity to inform the readers of SCIENCE of the isolation of "Ergobasine," its characteristics and the reasons for selecting this particular name. The report of H. H. Dale will be supplemented from the chemical

[5] Tisserand, "Mécanique Celeste," Vol. 4: 535.

[1] H. C. Plummer, "Dynamical Astronomy," pp. 177–179.

[1] SCIENCE, Supplement, p. 10, March 29, 1935, and 81: 559, 1935.

[2] SCIENCE, 81: 388 and 614, 1935.

[3] SCIENCE, 81: 636, 1935.

[4] SCIENCE, 82: 16, 1935.

[5] SCIENCE, 82: 99, 1935.

standpoint and an effort will also be made to clarify the question of identity of the different preparations.

The investigations of C. Moir[6] and M. R. Thompson[7] in 1932 gave indications of the existence of a then unknown active substance in ergot of rye, which by oral administration caused a quicker contracting action on the uterus than the alkaloids of the ergotoxine-ergotamine group. In our laboratories there were performed chemical, pharmacological and clinical investigations, to confirm the findings of C. Moir. The ergot of rye used for this purpose yielded a fair amount of ergotamine. The result of our investigations showed that the extracts had lost their activity on the human and animal uterus as soon as the alkaloids of the ergotamine-ergotoxine group had been removed. This proves the existence of certain kinds of ergot of rye which do not contain the new alkaloid.

Though we could not confirm the observations of C. Moir with our ergot of rye we continued the chemical analysis of ergot. When we changed the material for the production of alkaloids (ergotamine, ergotoxine) and employed Spanish ergot of rye, we discovered, at the beginning of this year, an alkaloid with unknown properties. This new alkaloid was isolated by purely chemical methods without resort to pharmacological or clinical tests. Because it differed in some important properties from the substances described in the literature, we suggested the new name "Ergobasine," due to its water solubility and relatively strong basic reaction in aqueous solution.

Meanwhile the publications of American and English investigators had appeared, describing the new active principle which with assistance of physiological tests had been isolated in a more or less pure form. As the work of these authors was essentially of a physiological nature and somewhat less chemically directed, there arose the names "Ergometrine," "Ergotocin," "Ergostetrine," all related to the action of the substance.

As long as a substance is not presented in a pure form and one does not know exactly its essential properties, it is quite natural to refer to its action in choosing a name. But such names might become unsuitable when new important therapeutic indications are discovered that differ from the first found characteristic actions. The Council on Pharmacy and Chemistry of the American Medical Association generally disapproves of names in which therapeutic indications are suggested and prefers terms based on the chemical nature or on the origin of a substance (Adrenalin, Insulin, etc.). "Ergobasine" indicates the origin and an important chemical property of the substance.

[6] *Brit. Med. Jour.*, No. 3728, p. 1119, 1932.
[7] *Jour. Am. Pharm. Assoc.*, 21: 853, 1932, and continuation.

In judging the claim of priority for the first isolation of a substance, the chemist requires more severe criteria than the pharmacologist. He expects a substance to be prepared in pure form, so that it may be characterized by important physical constants, by a complete analysis and an empirical formula derived thereof. We withheld our first publication until we were able to furnish all these data for the meeting of the Académie des Sciences in Paris, on May 13.[8] In the *Bulletin des Sciences Pharmacologiques*, May, 1935,[9] are published all the facts concerning the exact chemical and physical characteristics of pure ergobasine. Photographs of crystals of the pure base, from benzol and dichlorethylene, and of its hydrochloride, its sulfate, its tartrate and its picrate are also included in the paper. At that time comparable data on ergotocin and ergostetrine were completely missing and the physical and chemical findings by W. H. Dudley and C. Moir[10] differed on important points so greatly from our data, which had been determined with the pure substance, that we considered ergobasine to be a new alkaloid, different from ergometrine.

The English authors with ergometrine in 0.1 per cent. chloroform solution found a specific optical rotation [α] D = −45°, whereas we did not at all succeed in preparing a sufficiently concentrated solution of ergobasine in chloroform to make such a polariscopic reading because our alkaloid is almost insoluble in chloroform. The 0.25 per cent. aqueous solution of ergobasine, however, showed $[\alpha]_D^{20} = +90°$.

The measuring of the rotation of ergobasine in ethyl alcohol and mixtures with chloroform gave the following values:

$[\alpha]_D^{20} = +42$ (c = 0.8 in ethyl alcohol)

$[\alpha]_D^{20} = +44$ (c = 0.8 in 70 chloroform + 30 alcohol)

$[\alpha]_D^{20} = +36$ (c = 0.4 in 85 chloroform + 15 alcohol)

$[\alpha]_D^{20} = +23$ (c = 0.2 in 92.5 chloroform + 7.5 alcohol)

This demonstrates that we did not succeed in preparing a solution of our ergobasine preparation in pure chloroform, but our measurements seem to indicate, in comparison with the data of H. W. Dudley and C. Moir, that the English authors had a preparation which was contaminated with a strongly levorotatory substance. The impurity might have caused the solubility of their preparations in chloroform.

[8] C. R. Ac. Sc., 200: 1680, 1935.
[9] *Bull. Sc. Pharmacol.*, 42: 257, 1935.
[10] *Brit. Med. Jour.*, 3871, 520, 1935.

The values for the elementary analysis (C=71.46; H=7.38; N=11.66 per cent.) communicated by the English investigators in March, 1935,[11] as they say with reservation, differ so much from the theory of our ergobasine formula $C_{19}H_{23}O_2N_3$ (C=70.11; H=7.13; N=12.92 per cent.) that every chemist must conclude that Dudley and Moir analyzed either another or an impure substance.

H. H. Dale seems to have overlooked that in the report on Ergobasine, under the chapter, "Préparation de l'Ergobasine"[12] two methods for preparing ergobasine are given, which are based on the very slight solubility of the alkaloid in chloroform and its good solubility in water. These properties made possible the separation of ergobasine from the alkaloids of the ergotamine-ergotoxine group. Since then H. W. Dudley[13] also published a method for the preparation of ergometrine, but even here are missing the analyses of the base and its salts and the exact measurement of the optical rotation which would enable the chemist to identify the prepared substance. Ergometrine is now reported to be dextro-rotatory in ethyl alcohol. Only in a paper presented by C. Moir[14] we find the statement that ergometrine has, according to the investigation of H. W. Dudley, the formula $C_{19}H_{23}O_2N_3$, which is the same as we have found for ergobasine.

The data published so far on the identity of the substances prepared in different laboratories are briefly as follows:

W. A. Jacobs and L. C. Craig[15] have shown by direct comparison that the substance isolated by them from ergot of rye is identical with ergobasine. The independent analyses made by these authors confirm the formula $C_{19}H_{23}O_2N_3$ for ergobasine. The successful cleavage to lysergic acid and 2-aminopropanol-1 constitutes additional and valuable evidence for the formula, proving at the same time the connection between ergobasine and the alkaloids of the ergotamine-ergotoxine group.

A sample of 40 mgs ergostetrine, which Professor Thompson kindly sent us a few weeks ago in exchange for ergobasine, showed in crystalline form, water solubility and optical rotation in water ($[\alpha]_D^{20} = +88.5°$) the characteristics of ergobasine. Ergostetrine is therefore in all probability identical with ergobasine.

We have obtained from a trade package of ergometrine, of an English firm, an alkaloid preparation which was not homogeneous, but from which a fair amount of pure ergobasine was isolated.

The analyses reported by M. S. Kharasch and R. R. Legault[16] concerning their substance differ considerably from our ergobasine analyses and led to the formula $C_{21}H_{27}O_3N_3$ for ergotocin. The description of ergotocin as given by these authors differs from the published data on ergobasine, for instance, in the difficulties in salt formation of ergotocin with monobasic acids. Exact and direct comparison is still lacking. We did not fail to place a sufficient quantity of pure ergobasine for comparison purposes at the disposal of all the investigators who desired it.

That ergot of rye contains not only one alkaloid but several with the approximate molecular weight of ergobasine is shown by a recent communication of S. Smith and G. M. Timmis,[17] which describes the isolation of a new ergot alkaloid characterized by its decomposition point at 195°, its salt formation with HNO_3, HBr, and H_2SO_4 and by the very high optical rotation $[\alpha]_{5461}^{20} = +520°$ (c=1 in chloroform). The new substance named ergometrinine, with the formula $C_{19}H_{23}O_2N_3$, proved to be isomeric with ergobasine (ergometrine) and could be transformed into ergometrine. The newly discovered alkaloids seem to be a group of substances like the long known alkaloids of ergot, ergotinine-ergotoxine and ergotamine-ergotaminine, which are similar as a group, but possess different individual characteristics.

Through the exact physiological and chemical comparison of ergotoxine and ergotamine, we know that the chemical identity of substances can not be determined from the similarity of physiological action. For many years ergotoxine and ergotamine were supposed to be pharmacologically identical, and it is only recently that especially E. Rothlin[18] has shown some qualitative differences in the minute pharmacological activity of these alkaloids. Chemically, the difference of the two alkaloids was always evident.

The decision on the question of identity or difference of the newly prepared alkaloidal substances isolated by various investigators can of course only be determined by exact physical and chemical comparison.

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HETEROTHALLISM OF SUNFLOWER POWDERY MILDEW

THE formation of perithecia on only certain areas of diseased leaves and at the intersection of two mildew colonies indicated the likelihood of heterothallism of *Erysiphe cichoracearum* D.C. on sunflower, *Helianthus annuus* L. The formation of perithecia on young excised leaves floating on 5 per cent. sucrose solution

[11] *Brit. Med. Jour.*, No. 3871, p. 521, 1935.
[12] *Bull. Sci. Pharmacol.*, 42: 259, 1935.
[13] *The Pharmaceutical Journal*, June 15, 1935.
[14] *Brit. Med. Jour.*, No. 3890, p. 178, July 27, 1935.
[15] SCIENCE, 82: 16, 1935.
[16] *Jour. Am. Chem. Soc.*, 57: 956 and 1140, 1935.
[17] *Nature*, August 17, 1935, p. 295.
[18] E. Rothlin, *Archivio di Scienze Biologiche*, 18: 1–4, 1933, and *Klin. Wsch.*, 12: 25, 1933.

in petri-dish moist chambers at room temperature indicated that four of the conditions commonly cited as favoring perithecium formation, namely, old leaves, a host in a low state of nutrition, a dry atmosphere and low temperature, did not satisfactorily account for the formation of perithecia in this case. Fifteen single conidium cultures were isolated and maintained on excised sunflower leaves on sucrose solution. One of these single spore cultures has been maintained for over four months and all of them for six weeks or more under various cultural conditions without showing any tendency towards perithecium formation. Various combinations of these cultures were made, and perithecia were formed when certain cultures were combined. Two single conidium cultures, 1 and 1A2, which formed perithecia on combining, were studied in more detail. In two out of three tests with excised leaves floating on sucrose solution, and in three out of three tests with excised leaves with their petioles in flasks of mineral nutrient solution, perithecia were formed, though rather sparsely in most tests, when sunflower leaves were inoculated at the same place with both cultures. In one test, all twelve inoculations with culture 1 alone, and all 12 inoculations with culture 1A2 alone, formed conidia only, while seventeen out of twenty inoculations with the two cultures together formed perithecia in addition to conidia. This is considered to be reasonable proof of heterothallism in *Erysiphe cichoracearum* and is believed to be the first record of heterothallism in the *Erysiphaceae*. Cytological studies of the phenomenon are being conducted by Dr. Ruth Allen.

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RARE AQUATIC PHENOMENA

THE early morning of August 1 saw the beginning of an occurrence that, so far as the writer can find out, has never happened in this part of the country before, and is only recorded in a very few places throughout the world during the past fifty years or more.

About 18 miles north of New Haven, Connecticut, between the towns of Wallingford and Meriden, is a small lake known as the "North Farms reservoir." It is not over fifty feet above sea level; the surface area is between 125 and 150 acres, and it receives the drainage from a small basin of not over one square mile in extent. The lake has no inlet; it is spring-fed and very shallow, being only 8 feet deep in the deepest part, with an average mean depth of about 4 feet. The bottom is mostly mud and very full of weeds.

On the morning of August 1 the writer was called on the phone by Mr. S. R. MacDonald, a fruit grower whose property borders on the lake, and was told that "the whole surface of the lake was covered with fish of all kinds and sizes, that were breaking water incessantly, and that many of them were dead and dying." It took only a few minutes to reach the lake, and the sight was one never to be forgotten. Literally every square foot of the surface had one or more fish trying to breathe with their noses out of water. The fish consisted of pickerel, perch, calico bass, bullheads, sunfish and pond shiners.

Shortly after noon the fish were dying by the thousand and sinking to the bottom, while those that had been the first to die, probably during the night before, began to rise to the surface. In the meantime the water began to assume a peculiar milky color that was far from normal.

The shore-line of the lake was thoroughly examined. The vegetation along the shore showed no discoloration, nor any other sign of the action of poison, which every one seemed to suspect was at the bottom of it. In the meantime more and more fish kept coming to the surface and heading for shallow water. In some instances they even swam up on the banks where they were high and dry, and continued flopping around until they died.

Late in the afternoon Dr. Copeland, of the State Board of Water Supply, came down and analyzed the water from samples taken at different depths, all of which showed that practically all the oxygen had been exhausted, barely a trace showing in the analysis. Dr. G. E. Hutchinson, of Yale University, also came up to investigate the phenomena, and the results he obtained coincided with those of Dr. Copeland. A number of fish, both alive and dead, were taken to Professor Charles R. Hoover, of Wesleyan University, who after performing autopsies on the specimens gave as his opinion that the fish had died from a complete lack of oxygen, no trace of copper or other poisonous matter being present.

At the time of the catastrophe the pond had been "working" for several days, while a few days before there had been some severe rains, accompanied by abrupt changes in temperature. It seems that the decaying vegetation washed into the lake by the rains, plus the sudden changes in temperature, caused the sudden decaying of the Algae, which in turn caused a precipitation of decayed vegetable matter that absorbed all the oxygen. This naturally led to the suffocation or drowning of all the fish. It is estimated that over 400,000 fish died, and that not one was left alive. Even the eels and crawfish crawled out on the banks to die.

DAVID TOMLINSON

WALLINGFORD, CONN.

SCIENTIFIC BOOKS

PSYCHOLOGY

Psychology: A Factual Textbook. By E. G. BORING, H. S. LANGFELD, H. P. WELD and Collaborators. xviii + 555 pp. John Wiley and Sons, New York, 1935.

DESPITE their yearning, since the middle nineteenth century, to make psychology look like physics and physiology, the psychologists have remained irrepressibly critical and philosophical, even in the presence of their undergraduate students. E. B. Titchener, some twenty-five years ago, and John B. Watson, a decade later, succeeded in writing thoroughly dogmatic text-books, but neither was able to set a style. Both of these authors achieved consistency by omitting material embarrassing to their own views on fundamental questions, and the majority of teachers have been unwilling to employ such arbitrary tactics. The persistent popularity of such a human and variegated work as Professor Woodworth's text is clear evidence that teachers of psychology still prefer a certain amount of confusion to any strictly doctrinaire treatment of their subject.

The editors of the present book are unwilling to admit, however, that a straightforward and non-philosophical treatment of the elements of psychology must necessarily be dogmatic. "Experimental psychology," they say, "has reached the stage of maturity. There is a vast amount of well-substantiated fact which forms the foundation of the science" and which "should be presented to the young student of psychology in terms free from the bias of metaphysical presuppositions or of psychological systems." Their aim, in short, "has been to present such a factual text as one would expect from a science." They have sought "to achieve, not a handbook encumbered with a mass of detailed information, dates, the names of investigators and the titles of monographs, but a generalized statement of fundamental facts in so far as generalization is possible at this time."

The gist of their method is to let current psychology tell its own story through the pens of nineteen active investigators. The book is by no means a recitation of disconnected facts, but the theories and hypotheses considered are those which are presumably open to experimental and factual settlement.

The success with which the book fulfills its aim is remarkable. The editors and authors have produced a continuity and lucidity which one rarely associates with collections of chapters by different writers. One gets the impression from the progression of the chapters and from the skilful employment of cross-references that the various contributors kept constantly in mind the larger story into which their individual chapters were to fit.

The general design of the work may be judged from the chapter titles: The Nature of Psychology, The Response Mechanism, Psychological Measurement, Vision, Audition, Taste and Smell, Somesthesis, Intensity, The Perception of Spatial Relations, Temporal Perception, The Perception of Movement, Perceiving, Learning, Imagery, Pleasantness and Unpleasantness, Emotion, Action, Thought, Personality.

The editors, themselves, feel that inequalities in the actual attainments of research within the various areas of psychology may have created an uneven balance among the several chapters of their book. Out of a total of 535 pages, about 90 are devoted to perception. The discussion of the measurement of intelligence, on the other hand, is compressed into seven pages. I find it difficult to believe that investigation in the field of perception has progressed more than twelve times as far as in the measurement of intelligence, but I am not sure that the editors have any need to apologize. I happen to believe that the topics of work and fatigue (which are omitted in this text) contain much more that is definite in the way of both method and conclusion than do other topics which are dealt with at considerable length. But this proves nothing; it simply raises the question whether the editors in their allotment of space were able to use as their basic criterion the actual progress attained in the various lines of experimental inquiry. They have probably put through a better book by following their own sense of the important rather than the statistics of titles in the journals or a mail vote of the American Psychological Association.

In short, the text before us is a solid but clear statement of the elementary facts and methods of psychology as these appear to a group of fair and able men who, though biased by the traditions of what is known as "experimental" psychology, have yet succeeded in producing a work that is essentially up-to-date and catholic.

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LIMNOLOGY

Limnology. By PAUL S. WELCH, professor of zoology, University of Michigan. McGraw-Hill Book Company, 1935, pp. xiv + 471. Price, $5.00.

ALTHOUGH limnology is a youthful science, research has been very active in this field during the past three decades, and this has resulted in a voluminous and

widely scattered literature. It has been a difficult problem, therefore, to obtain representative material for an introductory course. This task is now greatly simplified by the present book, which is an outgrowth of a general course in limnology that has been given by the author for a number of years. The content of the book has been well and adequately selected and it is based chiefly on results obtained on American lakes and streams.

The subject-matter is fourfold in character, since it deals with the geology, physics, chemistry and biology of fresh waters. The geological part relates to the origin of lake basins, the dynamic action of the water on the shores and the great diversities in area, depth and elevation of lakes and in the character of their bottom deposits.

In the chapter dealing with the physical properties of lake waters, the annual cycle of temperature changes is discussed, together with the thermal stratification of the water, the heat budgets of lakes, the annual temperature changes in the bottom deposits and the penetration of solar radiation into different types of lake water. The quantity and quality of the radiation that reaches different depths are greatly affected by the color of the water.

The chemical discussion of lake waters includes a consideration of the dissolved gases, silica, phosphates, nitrates, calcium, magnesium and various other inorganic substances that are found in fresh waters. Also the organic matter that is present in the colloidal state or in true solution is discussed at some length.

Chapters VI and VII are devoted to a discussion of the effect of the physical and chemical conditions that obtain in lakes on the biota and to the various responses shown by aquatic plants and animals to the seasonal changes in these conditions.

The main part of the biological section (chapters VIII to XIV inclusive) deals with the various aquatic organisms and with the problem of the biological productivity of lakes; emphasis is placed on the latter and it includes the production of plankton as well as that of the bottom-dwelling animals and the large aquatic plants. The food value of this material is given consideration also.

The last three chapters relate to special types of water, such as ponds, bog lakes and streams. A good classified bibliography covering 54 pages completes the book.

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SPECIAL ARTICLES

CONCERNING ACTIVE IMMUNIZATION IN POLIOMYELITIS

THAT *Macacus* monkeys can be rendered actively immune to the virus of poliomyelitis has been known since 1910.[1] At that early date the important fact was also discovered that in process of the immunization, in which living virus was employed, a proportion of the treated monkeys, instead of becoming immune, always became paralyzed. The means employed in the treatment were to make successive injections of the virus beneath the skin; later the injections came to be made into the skin itself, which is still the method of choice in the monkey.[2] There is no essential difference in the double effects produced, except that skin injections seem to yield a higher degree of immunity.

Numerous and varied attempts have been made to modify the virus so as to preserve the immunizing properties and to remove the paralyzing action. Both physical and chemical means have been employed, but the results have not been satisfactory. Whenever the modifying agents inactivated the virus, no immunity followed the inoculations; when they reduced the activity, immunity would result, but paralysis also.[3] The effect of the physical and chemical agents seemed to be quantitative only; a dilution, not an attenuation, of the virus was produced. The virus recovered from the paralyzed monkeys injected with the chemically treated virus resembled in virulence the original virus strain before treatment was begun.

During the twenty-five-year period which has elapsed since the first experiments on immunization were made, certain virus strains have been passed through many *Macacus* monkeys. An effect of this passage was to enhance the virulence of some, but not of all the passed strains. It is noteworthy that the virus of poliomyelitis is strikingly unstable in its disease-producing or pathogenic properties; for reasons not understood specimens of high virulence will suddenly fall off in activity, after a time regaining the lost power while being preserved in glycerol.[4] On the other hand, some strains of virus possess enduringly weak activity; they are difficult to work with, because of the frequent failure to induce infec-

[1] S. Flexner and P. A. Lewis, *Jour. Am. Med. Assn.*, 54: 1780, 1910.

[2] W. L. Aycock and J. R. Kagan, *Jour. Immunol.*, 14: 85, 1927.

[3] F. W. Stewart and C. P. Rhoads, *Jour. Exp. Med.*, 49: 959, 1929.

[4] S. Flexner, P. F. Clark and H. L. Amoss, *Jour. Exp. Med.*, 19: 195, 1914.

tion in the monkey. Probably only the most highly susceptible animals respond to the weak strains when large doses are administered.

The statement has been made that the Rockefeller Institute passage "mixed virus" has gained in virulence for monkeys and declined in activity for human beings.[5] There is no experimental evidence supporting this statement. Indeed, aside from the unexplained and temporary fluctuations in activity, referred to above, this strain has remained remarkably constant; probably for this reason it has been sought by investigators in all parts of the world. The assumption that adaptation of the virus to monkeys is accomplished at the expense of diminution of pathogenic power for man is not only to go beyond existing knowledge, but is negatived by the observed effects when original human virus is employed directly for the immunization of monkeys.[6]

The term "human virus" simply means that portions of the spinal cord from fatal cases of poliomyelitis are used for the inoculation of monkeys, without having been passed through monkeys previously. This material can be preserved in glycerol, as can the monkey passage virus. When the human virus is injected successively into the skin of *Macacus* monkeys, it produces active immunity in the greater number, but paralysis in a proportion of the inoculated animals, just as the passage strains do. The same is true of early passage strains which have not had time to become specially adapted to the monkey.

Now, the human virus must have passed an indeterminate number of times through human beings in the course of the epidemics of poliomyelitis which have occurred as natural phenomena for scores of years. And yet, this virus has retained the property of both immunizing some monkeys and paralyzing others on repeated small injections. Probably the more refractory become immune, and the more susceptible paralyzed; no way is known of identifying the two varieties of animals prior to inoculation, just as there is no known method of selecting the small proportion of children falling victims to poliomyelitis during epidemics, from the large proportion passing through the outbreaks unattacked.

The experimental studies on which the statement of the effects of human strains and early monkey passage strains of the virus is based were carried out during the 1931 epidemic of poliomyelitis in New York State.[7]

[5] J. A. Kolmer and A. M. Rule, *Am. Jour. Med. Sci.*, 188: 510, 1934; J. A. Kolmer, G. F. Klugh, Jr., and A. M. Rule, *Jour. Am. Med. Assn.*, 104: 456, 1935; J. A. Kolmer, *Ann. Institut Pasteur*, 55: 365, 1935.

[6] S. Flexner, *Jour. Am. Med. Assn.*, 99: 1244, 1932.

[7] The data relating to this subject will appear in a paper to be published in the *Journal of Experimental Medicine*.

The observations on which the preceding statement is based may be summed up as follows:

(1) No adequate evidence has been presented showing that through the action of physical and chemical agents the virus of poliomyelitis may be attenuated so as to preserve its immunizing properties, while being deprived of its potential paralyzing power.

(2) The available evidence indicates that virus exposed to injurious physical and chemical agents is either inactivated (destroyed) or merely reduced in concentration. When the virus is actually destroyed, it no longer possesses immunizing power; when it is reduced in concentration, it immunizes certain animals and may paralyze others. The proof that the treated active virus has not been attenuated is provided by the recovery of fully active virus from the paralyzed animals.

(3) No evidence exists showing that passage of virus through monkeys removes its power to infect and produce paralysis in man. On the contrary, we possess convincing observations which show that an indeterminate number of passages of virus through human beings does not deprive it of its potential paralyzing effect when injected into monkeys.

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THE ERGOT ALKALOIDS. SYNTHESIS OF 4-CARBOLINE CARBONIC ACIDS

A PROVISIONAL structure for lysergic acid (3-propenyl-4-methyl-3, 4-dihydro-4-carboline-5-carbonic acid) has been suggested,[1] based on the interpretation of analytical data, of its properties and of the substances obtained from it by alkali fusion. Such a structure, if correct, would therefore place this acid in close relationship to the *harmala* group of alkaloids. Parallel with the continuation of the study of its degradation by different procedures, we have been attempting to check the validity of such a structure by synthesis.

The first steps in the synthesis have been readily realized by an extension of the method used by Tatsui[2] and by Akabori and Saito[3] in which tetrahydroharman was produced by the condensation of tryptamine with acetaldehyde. By the substitution of tryptophane[4] itself for tryptamine in this reaction we have found that a number of 3-substituted tetrahydrocarboline-5-carbonic acids have become readily acces-

[1] W. A. Jacobs and L. C. Craig, *Jour. Biol. Chem.*, 111: 455, 1935.

[2] G. Tatsui, *Chem. Centralbl.*, II: 668, 1928.

[3] S. Akabori and K. Saito, *Ber. chem. Ges.*, 63: 2245, 1930.

[4] W. O. Kermack, W. H. Perkin, Jr., and R. Robinson, *Jour. Chem. Soc.*, 119: 1616, 1921.

sible. Thus, tryptophane and formaldehyde gave 3, 4, 5, 6-tetrahydro-4-carboline-5-carbonic acid (Found: C 66.70, H 5.26). With acetaldehyde the 3-methyl derivative was formed, which melted with decomposition at 295° (Found: C 67.66, H 5.96). Condensation with paraldol gave the 3-β-hydroxypropyl derivative melting at 261° (Found: C 65.32, H 6.57). Crotonic aldehyde gave an amorphous substance (Found: C 69.72, H 6.48), and finally with benzaldehyde the 3-phenyl derivative was obtained which melted at 223–226° (Found: C 73.85, H 5.45).

Since in the formation of these substances a new center of asymmetry is produced at carbon atom 3, the production of epimers is a possibility in all cases except that in which formaldehyde is employed. In the case of the crotonic aldehyde product, the double bond of the propenyl side chain introduces, in addition to the possibility of shift, the added complication of cis trans isomerism. The results of the examination of our substances from this standpoint will be reported elsewhere.

Finally, as a next step, attempts have been made to prepare derivatives containing an N methyl group at position 4, by direct methylation of the above substances as well as by the substitution of N-methyl tryptophane[5] for tryptophane in these condensations. Thus, benzaldehyde has given 3-phenyl-4-methyl-tetrahydro-4-carboline-5-carbonic acid, which melted with decomposition at 199–201°.

These synthetic substances, however, do not give the delicate color reaction with dimethylaminobenzaldehyde so characteristic of lysergic acid and its derivatives. In the case of the Keller reaction, only the crotonic aldehyde condensation product gives a prompt color approaching that exhibited by lysergic acid and its derivatives. The other derivatives studied, as well as harmine and harmane, give practically negative Keller reactions.

Since it is not excluded that the carboxyl group of lysergic acid may be attached to carbon atom 3 of the carboline system, parallel attempts to prepare carboline 3-carbonic acids are also in progress.

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THE PREPARATION AND DETERMINATION OF TREHALOSE IN YEAST

TREHALOSE, a non-reducing disaccharide, has long been known to occur in certain fungi. In 1925 Koch and Koch succeeded in demonstrating that trehalose is also present in yeast.[1] They extracted 40 pounds of dried baker's yeast with alcohol and obtained a crystallized product, which they identified by melting point, optical rotation and molecular weight. No information as to the yield obtained was given. Robison and Morgan,[2] using alcohol extraction and acid hydrolysis, concluded that there is about 200 mg of trehalose present per 100 grams of dried yeast.

In a study of the carbohydrates in yeast it was found that a much better yield can be obtained by a different method of extraction, so that 1 to 2 grams of crystalline trehalose can be prepared from 300 grams of yeast. Treatment of the yeast[3] with NH_2SO_4, followed by precipitation with heavy metal ($HgSO_4 + Fe_2(SO_4)_3$ in 7.5 per cent. H_2SO_4) extracts the trehalose completely, while only traces of the polysaccharides present in yeast are extracted. During the subsequent neutralization with $BaCO_3$, the small amounts of polysaccharide present are precipitated, while the trehalose remains in solution. The filtrate is freed of barium and heavy metal and concentrated in vacuo. Addition of 20 volumes of 95 per cent. alcohol precipitates some salts, which are filtered off. The solution is placed in the refrigerator. After standing overnight, or in a few days, the typical rhombic crystals of trehalose are formed, which grow considerably in size in the next ten days. It was found that during glucose fermentation the trehalose content of yeast increases markedly. Use was made of this observation in one preparation in which 300 gm of yeast were allowed to ferment 150 gm of glucose. A gram and a half of trehalose was obtained in the first crystallization and six tenths gram by working up the mother liquor. The crystals were identified by melting point, 99–99.5° (uncorrected), specific rotation, $[\alpha]_D^{22} = 185°$ (C = 0.0497), water of crystallization 9.49 per cent. (calculated = 9.5 per cent.) and preparation of the octa-acetate. This compound melted sharply at 104° (uncorrected), $[\alpha]_D^{22} = 164°$ in chloroform (c = 0.1012).

		%	%
Acetyl determination $C_{12}H_{14}O_{11}(CH_3CO)_8$	Theoretical Found	$CH_3CO = 50.73$ $CH_3CO = 50.4$	
Elementary analyses[4] Trehalose $C_{12}H_{22}O_{11}.2H_2O$ 3.980 mg yielded 2.510 mg	Theoretical H_2O and 5.54 mg of CO_2 Found	C = 38.08 C = 37.96	H = 6.93 H = 7.06

[1] Koch and Koch, SCIENCE, 61: 570, 1925.
[2] Robison and Morgan, *Biochem. Jour.*, 22: 1277, 1928.
[3] We are indebted to Anheuser-Busch, Inc., for the supply of starch-free baker's yeast.
[4] We are indebted to Dr. Sidney Thayer, of the Department of Biochemistry, St. Louis University, for the carbon and hydrogen determinations.
[5] T. Hoshino, *Chem. Abstr.*, 29: 6596, 1935.

4.205 mg yielded 2.710 mg	H_2O and 5.830 mg CO_2		
	Found	C = 37.85	H = 7.21
Octa-acetyl trehalose $C_{28}H_{38}O_{19}$	Theoretical	C = 49.54	H = 5.65
3.440 mg yielded 1.695 mg	H_2O and 6.305 mg CO_2		
	Found	C = 49.99	H = 5.51
4.310 mg yielded 2.23 mg	H_2O and 7.83 mg CO_2		
	Found	C = 49.55	H = 5.79

Trehalose may be determined quantitatively in one gm of yeast by adding 10 cc of NH_2SO_4, diluting with water and precipitating with heavy metal. The filtrate obtained does not reduce alkaline copper solution, provided glucose added prior to the extraction of the yeast has been allowed to ferment completely. The filtrate is made normal with H_2SO_4 and hydrolyzed for 8 hours in the water bath. This converts 95 to 98 per cent. of the trehalose present to glucose. After removal of the H_2SO_4 with barium carbonate the glucose content is determined by means of the Shaffer-Hartmann copper reagent.

Fresh baker's yeast contains from 0.5 to 1.5 grams trehalose per 100 grams moist weight, the amount depending on the medium on which the yeast was grown. Aeration of a yeast suspension without added substrate lowers the trehalose content markedly. During fermentation of glucose the trehalose content may increase to 2 to 3 per cent. The biological significance of trehalose in yeast will be dealt with in a later report.

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THE ASCORBIC ACID CONTENT OF CERTAIN ORGANS OF CHICKS RAISED ON VITAMIN C DEFICIENT RATION

THE presence of a high concentration of vitamin C in the livers of chickens fed on a scorbutic diet has been reported by Hart, Steenbock and associates[1] and Carrick and Hauge[2] by biological tests. Recently Ray,[3] using the titrimetric dye method of Birch *et al.*,[4] found that although egg yolk and egg white both were devoid of vitamin C, after 4 days of incubation the embryo began to show the presence of ascorbic acid. The livers of the embryos after 15 to 19 days of incubation were found to contain 0.105 to 0.178 mg of ascorbic acid in the whole liver and after 21 to 24 days 0.226 to 0.273 per liver.

Using the titrimetric dye method, we have recently estimated the vitamin C content of different organs of over 20 chicks, fed on a diet free from vitamin C and with or without ultra-violet irradiation, from experiments on certain vitamin D studies and found that the adrenals, intestine and intestinal mucus as well as the liver all possess a high content of ascorbic acid, whether the chicks received ultra-violet irradiation or not, and further that the concentration of ascorbic acid in these organs did not vary during the growth period between the second and the third month.

Pancreas and kidney both contained a moderate amount of vitamin C, being about one third of that of the liver or intestine. The muscle was devoid of ascorbic acid. Both the intestinal contents of the small and of the large intestine possessed a trace of ascorbic acid, indicating that part of the ascorbic acid was excreted through the intestinal wall to the lumen.

Table I shows the average result obtained with the two groups.

TABLE I

ASCORBIC ACID CONTENT mg PER gm OF TISSUE

Ultra-violet irradiation	Muscle	Adrenals	Liver	Intestine	Intestinal mucus	Small intestinal content	Large intestinal content	Pancreas	Kidney
Yes ..	0	0.811	0.335	0.380	0.375	0.052	0.045	0.128	.100
No ..	0	0.915	0.302	0.391	0.404	0.047	0.056	0.134	.120

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SCIENTIFIC APPARATUS AND LABORATORY METHODS

APPARATUS FOR THE STUDY OF SENSORY DISCRIMINATION IN MAMMALS

IN the investigation of the functional characteristics of the receptors and nervous system of animals the need for methods permitting the elicitation and objective recording of responses to external stimulation is recognized. The present paper describes such a method, which has been found to be well suited to the analysis of all phases of the visually controlled behavior of the cat, and which may be modified for the investigation of the responses to other forms of exteroceptive stimulation in various typical laboratory mam-

[1] C. W. Carrick and S. M. Hauge, *Jour. Biol. Chem.*, 63: 115, 1925.

[2] E. B. Hart, H. Steenbock, S. Lepkovsky and J. G. Halpin, *Jour. Biol. Chem.*, 66: 813, 1925.

[3] S. N. Ray, *Biochem. Jour.*, 28: 189, 1934.

[4] T. W. Birch, L. J. Harris and S. N. Ray, *Biochem. Jour.*, 27: 590, 1933.

mals. The effectiveness of the apparatus is illustrated by presenting certain new findings concerning the discriminative behavior of the cat.

The apparatus here described (Diagram 1) is a

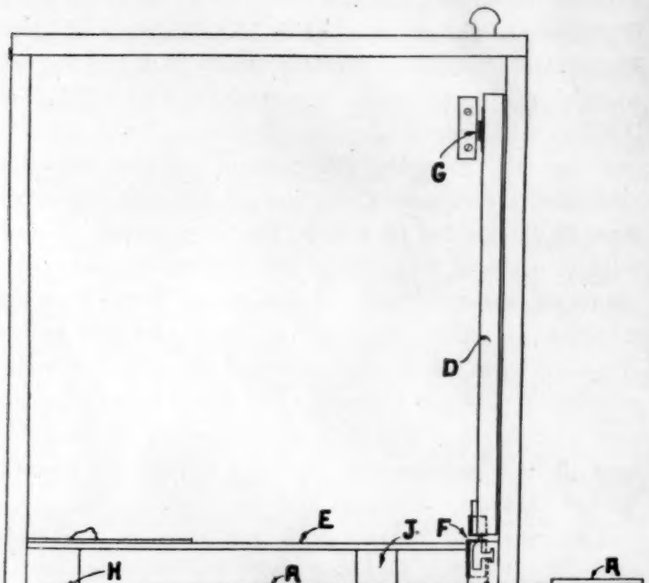

DIAGRAM 1. (A) lever, (D) door, (E) shelf, (F) latch, (G) rotary latch, (H) lever shaft, (I) spring support, (J) shelf support.

modified form of a method previously used by the writer in connection with experiments on pattern vision in the cat.[1] As arranged for work with this animal, the device consists of dressed poplar, 1.3 cm thick, cut and fitted into a box, 28 cm wide, 29 cm long, and 33 cm high. A door (D), a wooden frame 1.9 cm wide and 1.3 cm thick, swings inward by means of a light spring attached to its back. In the front side of the door are grooves into which ground optical glass or cards bearing various kinds of visual stimuli may be quickly inserted and removed. Inside the box, directly below the level of the door, is a shelf (E) for a food container. The shelf is so constructed that the door may swing inward without contact. The door is held tightly closed by a spring latch (F), to which is attached a brass lever (A), that extends 10.5 cm outward from the box and terminates in a brass plate of a size ample to accommodate the paw of the animal. The cat secures the food by depressing the lever and thrusting its head and forebody through the aperture of the opened door. The door may be closed by the rotary latch (G). Punishment by electric shock may be administered by leading a current through the lever and suitable conducting grills placed in front of the apparatus.

[1] K. U. Smith, *Jour. Genet. Psychol.*, 43: 462–466, 1933; 44: 301–320, 1934; 45: 336–357, 1934.

The lever consists of a 0.64 cm square brass rod, 32.4 cm long, to the outer end of which is screwed a small rectangular brass plate, 7.5 cm by 5 cm, rounded at the corners. A shaft (H) fitted into wooden supports (C), 2.5 cm high, serves as a fulcrum for the lever, the tension of the latter being controlled by a spring support (I). The shelf (E) is held 2.5 cm from the floor of the box by the supports (C) and (J).

Immediately below the door on the inside of the front panel is a spring latch (F), its catch being screwed to the inside of the door. The brass lever is drilled and fitted with a small hook directly underneath the plunger knob of the latch. Small rubber bands, giving greater tension than the latch spring, are led through the small hook and around the plunger knob of the latch. Thus, the door opens at the slightest touch of the lever, though the lever can thereafter be depressed to the floor. The rotary latch (G), which determines whether or not the door may be opened, is mounted on the upper edge of the frame of the door and catches against a wooden stop when rotated at a right angle.

With this apparatus, responses to pattern, brightness and movement differences in visual stimulation have been investigated so far in over thirty animals. In general, on the basis of these studies it can be said that cats learn situations involving brightness differences to a statistically significant criterion more quickly (100 to 200 trials) than they do situations involving any sort of pattern differences, whether moving or stationary (150 to 500 trials). Loud auditory stimuli, secured by sounding buzzers inside the box, have been demonstrated to elicit discriminative responses immediately in animals already trained to respond to visual differences. In further experiments, now being carried out, the apparatus has also been found to be suitable for the investigation of post-operative disturbances of visually controlled responses in relation to removal of limited regions of the cortex.

In the experiments just mentioned the following general procedure is followed. The animal is first trained in the habit of depressing the lever on a single box and obtaining a small bit of salmon placed on a food-tray inside. Two or more boxes, the doors of which contain appropriate visual stimuli, are then presented, and the animal is required to select an arbitrarily designated positive stimulus from one or more negative stimuli, the relative position of the stimuli in the boxes being changed from trial to trial in a chance order.

For establishing differential responses to visual patterns (for example, circles and triangles of equal area) two, three or four boxes are placed at the end of a long table, on the opposite end of which is located

a restraining cage for the animal. Cards bearing visual figures are inserted in the doors. The same arrangement of the boxes may be successfully employed in the investigations of responses to brightness differences from reflected light by inserting standard neutral-tint papers in the doors. Buzzers or loud speakers mounted at the back of the boxes permit rapid investigation of differential responses to auditory stimuli. Determinations of responses to transmitted light are made by constructing diffusing screens and filter holders at the back of the boxes and inserting optical-glass plates in the doors. Intensity variations are quickly made by a series of neutral-tint filters (10.2 cm by 12.7 cm). For visual acuity measurements two boxes are mounted on runways, 5 cm wide by 215 cm long, and separated by a distance of 50 cm, which are connected to the end of the table. The animal is then required to make a differential response which is a function of the test stimuli (a horizontal and a vertical black line) at the end of the table. The stimulus distance is controlled by the position of the movable boxes along the elevated runways. When responses to moving stimuli are under investigation, boxes containing plate-glass backs are employed, and the shadows of moving figures projected upon optical-glass screens in the doors.

The following statements indicate something of the general nature of the visually controlled responses of the cat as determined by this method. Animals trained in the discrimination of visual patterns (circles and triangles of equal area) give generalized responses to similar forms of different brightness, size, figure-ground relation, etc., or are able to select a previously learned figure from among a number of different new patterns (8 animals). With transmitted light differences, the brighter of two lights may be decreased to a ratio of approximately 1.3 that of the second light at brightness levels of 0.5 and 50 apparent foot-candles and still elicit differential responses (7 animals). With reflected light differences, the threshold ratio is approximately 1.4 at a brightness level of approximately 40 apparent foot-candles (1 animal). The visual acuity varies with the stimulus distance, being best at 50 to 75 cm (0.45 to 1.7 minutes) and less precise at 100 to 125 cm (1.4 to 3.4 minutes), when the discrimination is based upon a black horizontal lines versus a black vertical line (2 animals). The threshold of discriminative response to a moving cross versus a non-moving cross is approximately 1 cm per second angular velocity (4 animals).[2]

In every case, the bona-fide nature of the responses may be established by check experiments made during the course of each investigation. The results indicate that the apparatus has the advantage not only of eliciting an unequivocal response which can be demonstrated to be a function of the differential stimuli presented, but also of providing general experimental conditions that are readily modifiable for different types of investigation and easily controlled. Olfactory influences, for example, are controlled by placing food behind the doors of each box, and by alternating the position of the stimuli independently of other parts of the apparatus. Extraneous auditory influences and cues from the experimenter are excluded, since the animal itself manipulates all movable parts of the apparatus when making a response, and since the observer is shielded from the apparatus by appropriate screens.

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[2] J. L. Kennedy and K. U. Smith, *Jour. Genet. Psychol.*, 46: 470–476, 1935.

THE "CONTOUR" CHART AND ITS IMPORTANCE IN PUBLIC HEALTH TABULATIONS[1]

IT is often necessary to express data in as little space as possible and at the same time make it immediately evident. I believe the chart herein described will aid in this respect.

Neyman[2] and Neyman and Pearson[3] used the term contour in describing lines representing a constant of different sizes of samples of population. Their diagrams were highly technical. Treolar and Wilder[4] also used the term contour with reference to lines in a highly technical diagram. In a recent study of the incidence of epidermophytosis[5] I have used the term with reference to certain charts. In these charts three factors are plotted: one, on the ordinate, one on the abscissa and a third on the chart. Increments plotted on the chart are equal. The term "contour lines" is used in the same sense on topographical maps in plotting equal increments of elevation or depression and they are defined as lines drawn for equal differences of elevation and hence steepness, or the reverse, according to whether they are crowded together or spread apart. As will be noted in my charts, the term contour is used somewhat broadly but in a highly descriptive sense.

In Fig. I, years are plotted on the abscissa, cumulative cases on the ordinate and age groups of 10 years on the chart. In this chart the term contour is used somewhat broadly, since the lines connecting the

[1] Contribution No. 59 from the Department of Biology and Public Health, Massachusetts Institute of Technology, Cambridge, Mass.

[2] J. Neyman, *Biometrika*, 18: 1926, 406.

[3] J. Neyman and E. S. Pearson, *Biometrika*, 20–A: 1928, 175–235.

[4] A. E. Treolar and M. A. Wilder, *Ann. Math. Stat.*, 5: 1934, 340.

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points do not bound areas in continuous space. This figure we have labeled a "Contour Chart of Apparent Incidence," since age groups of population were not considered.

Fig. II is similar to Fig. I, with the exception that age groups of population have been taken into account. It is therefore called a "Contour Chart of Actual Incidence." In order to take the age group of population into account the following formula was used: $\frac{P}{U} = F$, where P (Peak) is the age group of largest number and U the age group for which the factor F is desired. This factor is then multiplied by the number of cases in the particular age group concerned so as to correct for variation in age groups of population.

In the above figures it will be noted that the lower incidence is in the lower and higher age groups. This

FIG. I

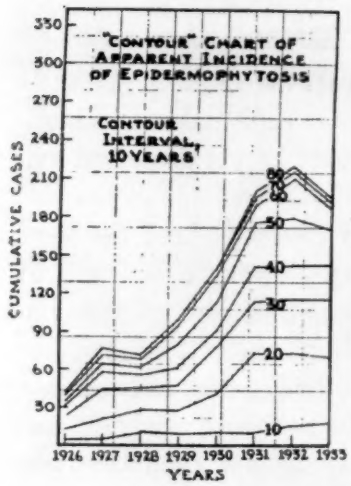

"CONTOUR" CHART OF APPARENT INCIDENCE OF EPIDERMOPHYTOSIS
CONTOUR INTERVAL, 10 YEARS
CUMULATIVE CASES
YEARS
1926 1927 1928 1929 1930 1931 1932 1933

FIG. II

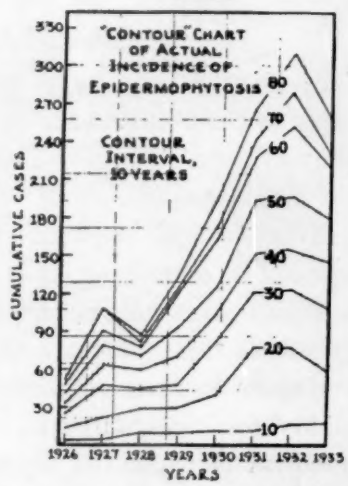
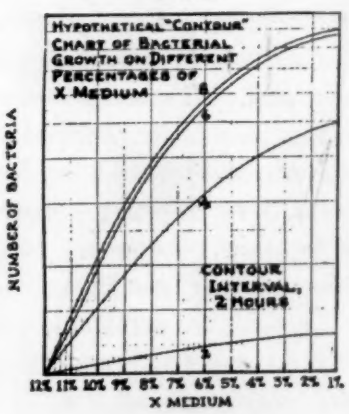

"CONTOUR" CHART OF ACTUAL INCIDENCE OF EPIDERMOPHYTOSIS
CONTOUR INTERVAL, 10 YEARS
CUMULATIVE CASES
YEARS
1926 1927 1928 1929 1930 1931 1932 1933

FIG. III


HYPOTHETICAL "CONTOUR" CHART OF BACTERIAL GROWTH ON DIFFERENT PERCENTAGES OF X MEDIUM
CONTOUR INTERVAL, 2 HOURS
NUMBER OF BACTERIA
X MEDIUM

is accounted for by less chance of exposure to the etiological agent. In addition, in the higher age group difficulty in getting to clinics might lead to greater neglect of a minor ailment. It will be noted in these charts that there is a somewhat general distribtuion of the disease indicating lack of development of immune bodies to the etiological agent. If, instead of epidermophytosis, we should plot chicken-pox the incidence would be large and almost entirely in the younger age group, indicating great contagion and development of immunity. Thus Fig. II is a chart taking into consideration not only yearly incidence with reference to age groups but also with reference to age group distribution of population, contagiousness of the disease and development of immunity to the disease. Many uses can be made of contour charts. For example, a hospital or public health department might plot diseases on the abscissa, cumulative cases on the ordinate and years or months on the chart and thus keep a record of the diseases in which they were interested or they might plot diseases on the abscissa, cumulative cases on the ordinate and age groups on the chart.

In Fig. III I have plotted on the abscissa concentration in percentages of a medium which we will call X, on the ordinate increase in the number of organisms and on the chart two hourly intervals. Semi-logarithmic paper is used so as to show proportionate increase with reference to the actual number of organisms present. In this instance the lines may be considered as bounding areas in continuous space and the term contour as used in a stricter sense than in the previous figures. This, too, is a compact way of recording and tabulating the data obtained.

In conclusion, I have submitted a chart which is considered of great value in recording public health and other data. It is simple and inclusive. While it might be considered in the category of composite charts the term "Contour Chart" is more descriptive and indicates that the increments on the chart are equal. It is felt that the "Actual Contour Chart" will encourage workers to take into consideration oftener such factors as age groups of population, etc., and thus promote the publication of more significant data.

I wish to thank F. F. Stephan, editor of the *Journal* of the American Statistical Association, for his helpful criticism.

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BOOKS RECEIVED

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